Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

aTC424
.M6W5

WIND - BIGHORN - CLARKS FORK RIVER BASIN
TYPE IV SURVEY
MAIN REPORT

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE

IN COOPERATION WITH

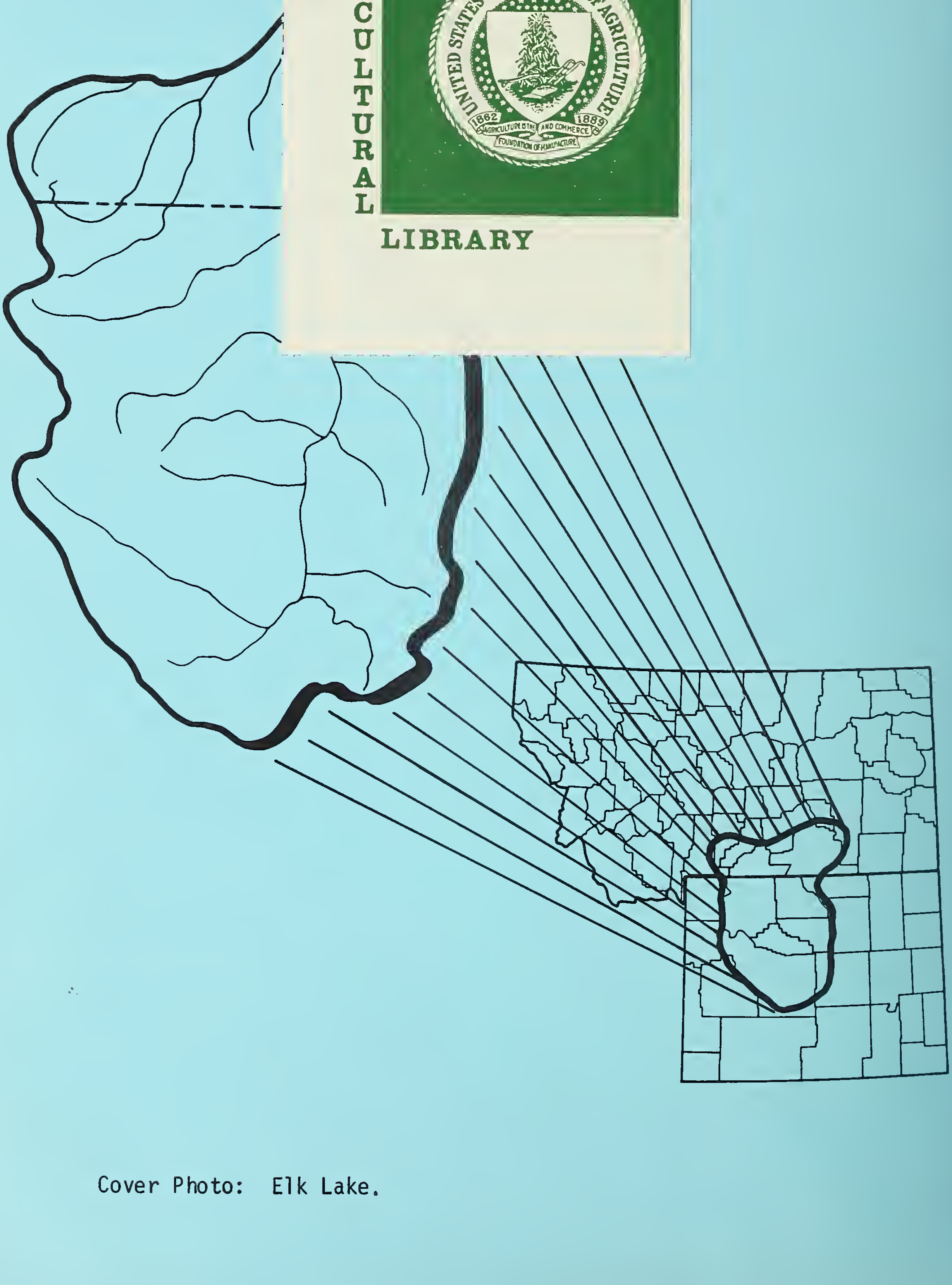
WYOMING STATE ENGINEER
MONTANA DEPARTMENT OF NATURAL
RESOURCES AND CONSERVATION

DECEMBER 1974

USDA-SCS-PORTLAND, OREG. 1975

AD-33 Bookplate
(1-63)

NATIONAL
AGRICULTURAL
LIBRARY



Cover Photo: Elk Lake.

MAIN REPORT

for the

WIND-BIGHORN-CLARKS FORK RIVER BASIN

Type IV Survey

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

WYOMING STATE ENGINEER

and

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

December 1974

Under direction of

USDA FIELD ADVISORY COMMITTEE

U. S. DEPT OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

JUN 27 1976

CATALOGING

395946

ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN

TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5 5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

WIND-BIGHORN-CLARKS FORK RIVER BASIN
TYPE IV SURVEY
MAIN REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

F I G U R E S

FIGURES (Continued)

T A B L E S

TABLES (Continued)

TABLES (Continued)

U.S. DEPARTMENT OF AGRICULTURE
WIND-BIGHORN-CLARKS FORK RIVER BASIN
WYOMING AND MONTANA

SUMMARY

GENERAL

A few miles south of Thermopolis, Wyoming, is a place on the river known as "Wedding of the Waters." At this place the Wind River changes its name and becomes the Bighorn River. The Bighorn, Clarks Fork, and Stillwater Rivers are southern or right-bank tributaries of the Yellowstone River. Together with a few other tributaries between them, they drain about 28,390 square miles in Wyoming and Montana. About 72 percent of this area is in Wyoming and 28 percent is in Montana.

This is a report of a survey of the water and related land resources of the basin. The objective of this study is to promote a coordinated, orderly program for the conservation, management, use, and development of these resources.

This is the main report of the survey and is a general report which relates to the entire river basin. More specific information for each state is contained in the "Wyoming Supplement" and the "Montana Supplement" which are separate reports.

PROBLEMS AND NEEDS

The major human problem in the basin is underemployment. This problem is more serious among residents of the Indian reservations but is not limited to them. Underemployment rates in the area are about 15 percent of the male labor force and 40 percent of the female labor force, for a combined 21 percent of the total labor force.

A related problem is that per capita income for the basin's residents is about 19 percent below the national average. An improved economy is needed to provide more complete employment and better income distribution for the people of the basin.

Employment opportunities are limited in this basin and out-migration is about 70 percent of the population reproduction rate. From 1940 through 1970, about 27,000 people moved out of the basin. This is greater than the combined population of the four largest towns in the basin.

The major water and land resource problem is inadequate land treatment and management. On nonfederal range and dry pasturelands, only 34 percent is adequately treated and managed. Only 15 percent of the irrigated cropland and 40 percent of the nonirrigated cropland is adequately treated and managed.

Related to the problem of inadequate land treatment is the problem of erosion. High rates of runoff flowing through unstable gullies and streams cause about 80 percent of the basin's erosion damage. Erosion results in loss of productive soil, reduced crop production, damaged fish and wildlife habitat, damaged recreation sites, decreased farming efficiencies, damaged structures, reduced land values, damaged utility lines, and impaired aesthetic values. The major causes of erosion are (1) sparse vegetation cover, (2) improperly located roads and trails, (3) inadequate logging roads and skid trails, (4) off-road vehicular travel, (5) overgrazing, (6) wildfires, (7) mining, and (8) high rates of runoff from spring thaws and summer thunderstorms.

Erosion generally results in sediment damages downstream. There is some sediment damage to croplands when floods occur, but other sediment damages are more important in the average year. Sediment settles in irrigation canals and about 20 percent of the total length of these canals must have the sediment removed each year. Sediment loads in streams reduce water quality for agricultural, municipal, domestic, and industrial uses. Sediment in streams injures or kills fish and other aquatic life and reduces their reproduction rates. Sediment trapped in reservoirs reduces water storage capacities. The total capacity of the three large reservoirs in the basin is reduced about 6,400 acre-feet each year by sediment.

Floods are a problem in that they cause an average of over $145,000 worth of crop and property damage yearly. About 75 percent of this damage is to agricultural areas on tributary streams.

There are about 145,900 acres of land in the basin with excess water problems. Many of these are agricultural lands and need improved drainage and irrigation water management to be fully productive for agriculture.

The most important water supply problem is a shortage of late season irrigation water on presently irrigated lands. While most of the irrigated lands supplied with water from the main rivers of the basin are not seriously short of water, most of the lands supplied from tributary streams do not have enough water for full production.

Another problem is that livestock water supply points are not well distributed for proper range management. There are some water pollution problems associated with mine acid discharge and briny water from oil fields.

Forest problems include stands of low quality timber, inaccessible timber, slow timber growth due to overcrowding, inadequately skilled woods workers, and a lack of processing plants for small timber. Full use of forest recreation resources is inhibited by inadequate access across private lands, uneven distribution of developed facilities, an inadequate road network, insufficient trails development, and uneven distribution of lakes and other water developments. Control of trespass over private lands results in overcrowding of some existing access points to the public lands. Development of summer homes on private forest lands in a poorly planned, uncoordinated

manner, with inadequate sewer systems and roads, threatens water, land, and forest quality. Insect and disease damages are high, and as much as 50 percent of the gross annual timber growth may be lost to insects and diseases. Inefficient harvest methods cause additional losses of wood.

In 1980 the demand for the basin's timber will exceed the supply by 3,000,000 cubic feet. The demand is expected to exceed the supply by an increasing margin through 2020. An accelerated action program is needed if the timber supply is to be increased.

The recreation use of the basin is expected to increase from about 6,512,200 to 13,489,100 visitor-days by 2020. This is an increase of 107 percent. During peak use periods, the supply of some recreation facilities, particularly for camping, is less than adequate. The present need is greater in the Montana portion of the basin. By 2020 the need for new camping facilities will be nearly as great in Wyoming as in Montana. Private lands near public lands offer the best opportunity for the development of recreational facilities.

Winter habitat is the main limiting factor for most big game populations. The quality and quantity of winter habitat areas in the basin are decreasing because of man's activities. Moose winter habitat is most critical and should not be further altered without careful study and action to prevent serious reduction of the habitat.

FINDINGS AND CONCLUSIONS

The 1970 population of the basin was about 90,176 people. The population is projected to increase 54 percent to 138,700 people by 2020. The increase may be even higher if coal mines are developed in the basin. However, the rural farm population is expected to decrease from 17,070 to 11,300 people during the same period.

Agricultural production is projected to increase. Irrigated cropland is projected to increase from 770,250 to 857,000 acres by 2020. Production per acre will increase as well. The gross value of agricultural production is expected to increase from about $75,179,000 to about $160,978,000 in the same period. Beef production is expected to increase from 193,110,000 to 463,711,000 pounds live weight per year. The value of feed needed for all livestock produced in the basin will increase from about $50,322,000 to about $88,205,000. Some of this increase will occur without accelerated USDA programs.

There is potential to increase agricultural production, enlarge the timber industry, provide more recreation facilities, increase full employment, solve many of the problems, meet most of the needs of the basin, and maintain a high quality environment through the application of accelerated USDA programs. The following paragraphs outline some of the opportunities for USDA programs which have been identified in this study.

About 85 percent of the irrigated land in the basin can support a 50 percent increase in production through improved water supplies, management, and land treatment. About 1,360,750 acres of land not presently irrigated are suitable for irrigation if water is made available. While conflicts in land use will occur, there is enough land for both agricultural and nonagricultural purposes if development is properly planned.

Even in the most water short areas, there is water in high spring flows and short summer floods which can be stored if feasible reservoir sites exist. However, most possible reservoir sites have problems of limited capacity, poor location, poor foundations, and high construction costs. Good locations for ten reservoirs have been identified in the survey.

Where irrigated lands already have a good seasonal water supply, water quality and crop production can be improved through more efficient control of irrigation water. Where this reduces tailwater runoff and water-logging of lower elevation lands, there will be a reduction in the use of water.

The potential for large scale ground-water development from valley alluvium is limited because of thin aquifers and the likelihood of depleting flows in nearby surface streams. However, ground water can be developed in many locations in the basin. Some aquifers can supply large artesian flows of good quality.

Range and forest lands can be managed to provide more grazing, timber, recreation, and improved wildlife habitat. The supply of timber could be increased 50 percent with a program for insect and disease control. More complete harvest and processing efficiency could provide a 70 percent increase in usable wood. Better forest management could also provide a 50 percent increase in wood supply.

Watershed investigation reports have been written and distributed for 21 potential small watershed projects in the basin. An accelerated land treatment program is also proposed for each state's portion of the basin. Development of these projects and programs through USDA action and assistance can help solve the problems and provide for the needs of the basin. By the year 2000 the proposed watersheds could increase the value of the agricultural production by $7,404,000. About 54 percent of this increase would result from improving the seasonal supply of water to presently irrigated land. The increased agricultural production from the installation of these projects could support as many as 910 permanent new jobs. The new income to the basin could be $5,800,000 per year.

When projects are developed, care should be taken that wildlife habitat areas near the project site are not seriously degraded or that alternate measures are provided for protecting wildlife values. Interagency cooperation leads to better use of fish and wildlife resources and provides for increased benefits.

The present and future needs of the people of the basin can best be met through the development and improved conservation of the basin's resources. Much can be done with the help of existing or accelerated USDA programs. Where opportunities or needs are beyond the scope of USDA programs, they can usually be helped along if USDA programs are included in interagency efforts. There is particular opportunity for cooperative state-federal projects and programs.

RECOMMENDATIONS

The following specific recommendations outline USDA opportunities to manage, conserve, or develop the use of water and related land resources in the basin.

1. The land treatment program for nonfederal land should be accelerated to about double the application rate of presently existing programs. This would increase the estimated total installation costs from $56,948,000 to $101,400,000 over the next 25 years. An acceleration of federal technical and financial assistance will be required and could be administered through small watershed projects, the existing resource conservation and development projects, and cooperative forest programs.

2. Development and nondevelopment alternatives for national forest land management are described in this report. The expected tradeoffs between these alternatives, especially between 80,500,000 board feet of sawtimber and wood products and 850,000 acres preserved for Primitive Area activities,will require more detailed studies to evaluate.

3. Twenty-one potential small watershed projects are described in the reports prepared for this study. All of these projects are recommended for construction as soon as local sponsors show an interest in their development. It is further recommended that any project involving the storage of water for agriculture should be developed as soon as possible so as to establish water rights for this use.

Although all of the 21 potential small watershed projects could be considered for early action, eight are recommended as high priority projects. Three of these proposed developments are in Wyoming and five are located in Montana. The total installation cost for these eight projects is estimated to be $18,505,000. The remaining 13 proposed watershed projects have an estimated installation cost of $13,797,000.

The proposed high priority projects are listed below:

Project	Principal Feature
Wyoming	
Lower Greybull	Drainage
Nowood River Watersheds	Supplemental irrigation water
Gooseberry Creek	Supplemental irrigation water
Montana	
Blue Creek	Flood prevention
Pryor Creek	Irrigation
Two Leggins	Agricultural water management
Upper Little Bighorn River	Irrigation
Lodge Grass Creek	Flood prevention

4. Project measure proposals in the Beartooth and Bighorn Basin Resource Conservation and Development Projects should be studied in detail to determine engineering and economic feasibility of potential developments. Feasible projects should be installed as soon as local sponsors are ready to proceed.

5. Several reaches of streams are listed in the report which could be studied for inclusion in the National Wild and Scenic River System. Stream classifications other than those used in this system might also be considered.

6. The Indian water rights issue needs to be resolved as soon as possible. USDA agencies could assist by providing information concerning agricultural water requirements if requested.

7. The quantification and definition of federal reserved water rights should be concluded as early as possible.

8. Research is needed to probe into the real physical and environmental effects of changing water use patterns in the basin.

I. INTRODUCTION

This is a report of a study of problems, needs, potentials, and opportunities for the development and use of water and related land resources in the Wind-Bighorn-Clarks Fork River Basin. Opportunities are identified for programs and projects which can be administered or assisted by agencies of the U. S. Department of Agriculture. This study is needed to provide information for coordinated, systematic, multi-purpose development of these resources. The objective of this study and report is to outline a coordinated, orderly program for the conservation, management, use, and development of these resources.

Information available in this report will be helpful in the development of Montana and Wyoming State Water Plans. State, local government, and private agencies involved in developing water and related land resources of the basin should find useful information in this report. This report provides agencies of the U. S. Department of Agriculture with information to assess the value and impact of ongoing programs, the potential for project developments, and the need for accelerated or new programs to better meet the needs of the people and conserve the basin's natural resources.

The basin includes the hydrologic drainages of the Wind River, Bighorn River, Shoshone River, Clarks Fork River, Stillwater River, Little Bighorn River, all of their tributaries, and some south-side tributaries of the Yellowstone River between Columbus and Bighorn, Montana. The total area of the basin is 18,167,990 acres or about 28,390 square miles. About 72 percent of the area is in Wyoming and 28 percent in Montana. The Yellowstone River Compact of 1950 allocates the interstate waters between Wyoming and Montana except those in the Little Bighorn River.

This study has been made under the authority of Section VI of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566) as amended and supplemented. By this act the Secretary of Agriculture is authorized to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds and rivers as a basis for development of coordinated programs. The State Engineer of Wyoming and the Montana Department of Natural Resources and Conservation have both requested this study and participated in it.

Data for this study were compiled, analyzed, and presented by employees of the Soil Conservation Service, Forest Service, and Economic Research Service with additional data and cooperation provided by other state and federal agencies. Table I-1 is a list of contributing federal and state agencies. Data, assistance, cooperation, and recommendations received from all other agencies are greatly appreciated.

The information presented in this report is generalized to describe the entire river basin. More detailed information for each state is available in the Montana and Wyoming supplements to this report.

Table I-1--Contributing agencies

U. S. Department of Agriculture

- Soil Conservation Service
- Forest Service
- Economic Research Service
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Rural Electrification Administration
- Cooperative Extension Service
- Statistical Reporting Service

State agencies

- Wyoming
  - Wyoming State Engineer
    - Wyoming Water Planning Program
  - Department of Aqriculture
  - Department of Economic Planning and Development
  - Department of Environmental Quality
    - Water Quality Division
  - Wyoming State Forestry Division
  - Game and Fish Department
  - Wyoming Recreation Commission
  - University of Wyoming

Montana

- Department of Natural Resources and Conservation
- Fish and Game Department
- Department of Health and Environmental Sciences
- Department of State Lands and Investments
- Division of Planning and Economic Development
- Bureau of Mines and Geology

Other federal agencies

- Bureau of Indian Affairs
- Bureau of Reclamation
- Bureau of Land Management
- Bureau of Sport Fisheries and Wildlife
- Geological Survey
- National Park Service
- National Weather Service
- Bureau of Public Roads

II. NATURAL RESOURCES OF THE BASIN

The relative amounts of natural resources available in a river basin have a major influence on the economic and cultural activity in the basin. Consideration must be given to location, climate, physiography, geology, soils, hydrology, plants, animals, scenic values, and other factors of the natural environment to properly plan for balanced resource development. The quantity, quality, and value of each of these natural resources affects the use and development of the other resources. This chapter contains inventories and descriptions of many of the natural resources of the basin.

LOCATION AND SIZE

The Wind-Bighorn-Clarks Fork River Basin lies in north-central Wyoming and south-central Montana extending from south of Lander, Wyoming, north to Bighorn, Montana. Yellowstone National Park shares some of the boundary on the west side of the basin, and the Bighorn Mountains form much of the eastern boundary. Most of the basin lies between the 42nd and 46th degree parallels (about halfway from the equator to the north pole) and the 107th and 110th degrees longitude, along the east flank of the Rocky Mountain Range. The basin area is about 28,390 square miles and includes about 21 percent of Wyoming and about 5 percent of Montana. About 72 percent of the basin is in Wyoming and 28 percent is in Montana. Figure II-1 is a map of the basin showing its location and counties involved in Montana and Wyoming. Table II-1 lists areas of major subbasins in the basin.

CLIMATE

The climate of the basin ranges from cool, semiarid deserts in the central floor of the basin, through a cool subhumid climate on the mountain sides, cold taiga,[1/] and very cold tundra to limited areas of perpetual frost and glaciers on the high mountains. The climate is more closely related to elevation than to latitude, and the elevation ranges from less than 3,000 feet at Bighorn, Montana, to almost 14,000 feet at Gannet Peak in the Wind River Mountains.

Precipitation varies both with elevations and location. A map of estimated average annual precipitation, developed from precipitation gage records, snow course records, precipitation-elevation curves, and a hydrologic simulation model, is presented in figure II-2. Precipitation in the mountains increases with elevation. Since much of the southern portion of the basin is surrounded by high mountain ranges, which wring most of the available moisture from approaching air masses, the lower central portions of the basin are deserts. The plains north of the Bighorn Mountains suffer

1/ Taiga is a cold, coniferous forest, mainly spruce and alpine fir, occurring in polar regions and on mountain slopes below the tundra province. Tundra is the even colder region with moss, lichens, and sedges.

Table II-1—Areas of major subbasins

Subbasin name	Area in Wyoming	Area in Montana	Total	Portion of total area
	---acres---			percent
Wind River	4,992,740	0	4,992,740	27
Bighorn River	7,196,060	1,763,010	8,959,070	49
Clarks Fork River	796,570	976,330	1,772,900	10
Little Bighorn River	193,670	637,720	831,390	5
Stillwater River		676,680	676,680	4
Yellowstone Minor Drainages		935,210	935,210	5
Total	13,179,040	4,988,950	18,167,990	100
Percent of total	72	28	100	100

less from this influence and receive more precipitation annually than some higher elevation areas farther south. Deep snowpacks develop in the mountains from fall, winter, and spring snows and melt in the spring to provide the most important source of streamflow in the basin.

Temperature varies more as a result of changes in season, vertical temperature inversions, and movements of air masses than from elevation. However, elevation is an important influence, and growing seasons are shorter as the elevation increases. Samples of recorded temperature extremes are -51° F. and 114° F. at Basin, Wyoming. The average annual growing season ranges from less than 60 days above 7,000 feet in elevation to 160 days or more near Basin, Wyoming; Billings, Montana; and at other locations less than 3,500 feet in elevation. Summers are warm, autumns are cool and pleasant, winters are cold, with some very cold spells in December and January, and spring is cool with frequent snows, rainstorms, and freezing spells.

Floods occur from a variety of causes. Warm rain on wet snowpacks in late winter and in the spring can cause extensive flooding. Rapid melting of mountain snowpacks in late spring causes general flooding along the larger streams. High intensity rainstorms often flood local areas in spring and summer. Alternate freezing and thawing can also cause ice jam flooding on large streams in late winter and early spring.

Evaporation rates are moderately high because of low relative humidity, high rates of wind, and a high percentage of days with sunshine.

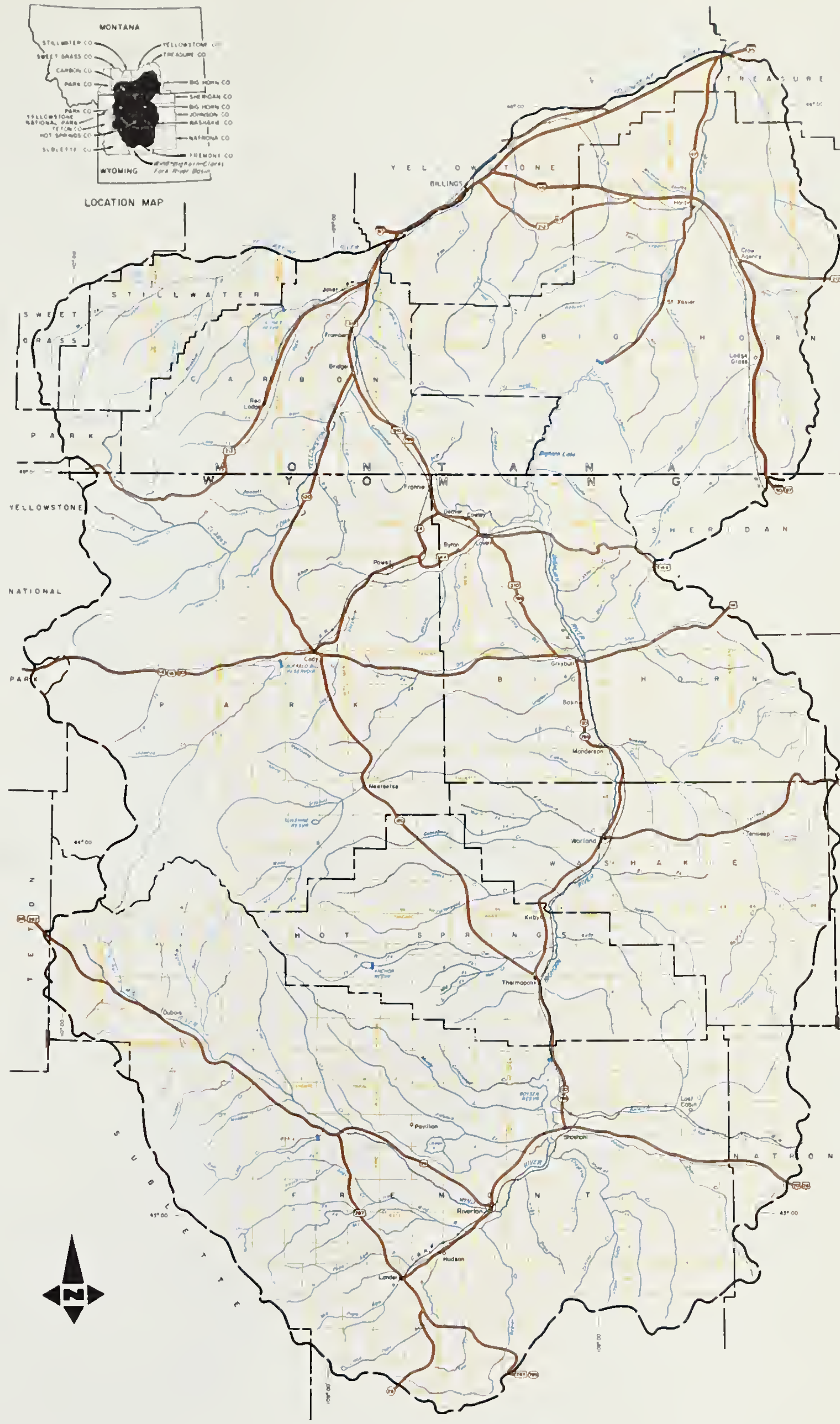


FIGURE II-1

PROJECT MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND OREG. 1975

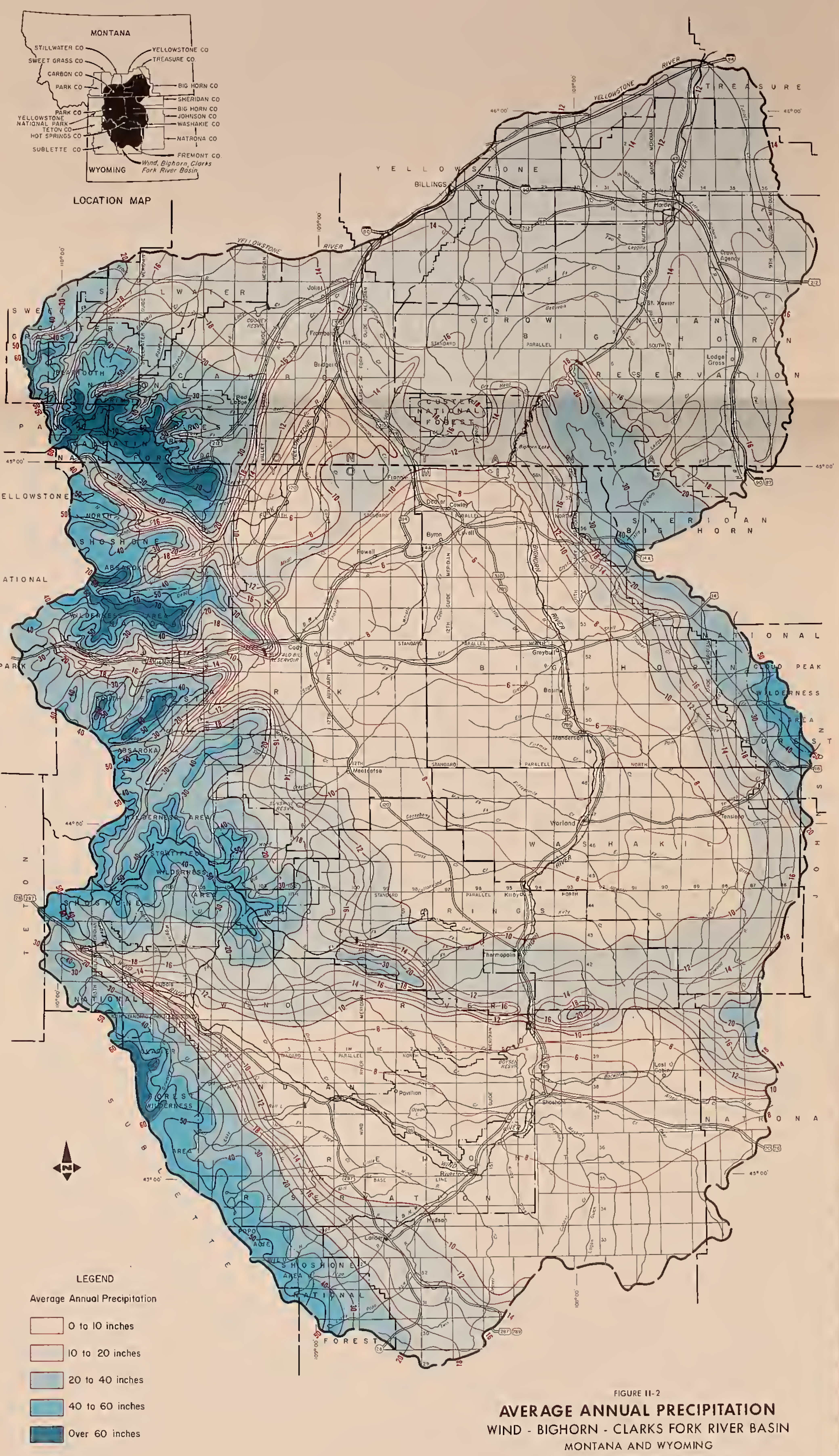


FIGURE II-2

AVERAGE ANNUAL PRECIPITATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

M7-EN-22441B

Winter lays a heavy blanket of snow on the mountains.

Soil moisture from snowmelt nourishes plants and animals in the spring.

PLATE 1

The deeply incised Bighorn Canyon now holds the water of Bighorn Lake. This magnificent scenic area, once very difficult to enter, can now be easily seen from a boat.

BUREAU OF RECLAMATION PHOTO

The Wind River Canyon--geologist's textbook, camper's delight, scenic wonder, and fisherman's paradise.

BUREAU OF RECLAMATION PHOTO

This basin produces an important part of the nation's oil supply.

PLATE 2

PHYSIOGRAPHY AND GEOLOGY

This river basin lies within the Northern Rockies and Great Plains physiographic provinces. It includes portions of the Wyoming-Bighorn Basins, Middle Rocky Mountains, and Upper Missouri Broken Lands physical subdivisions of land surface forms in the United States.1/ Mountain ranges bounding the basin on the west side include the Beartooth, Absaroka, and Wind River Mountains. The Bighorn Mountains form part of the eastern boundary. The Owl Creek and Bridger Mountains divide the Wind River and Bighorn River Subbasins in the south, and the Pryor Mountains are within the basin near the state line.

There are five major subbasins drained by the Wind, Bighorn (including the Shoshone River), Clarks Fork, Stillwater, and Little Bighorn Rivers. The rivers that drain these subbasins are primarily consequent2/ streams that have cut deep canyons through the highlands. Two of these are particularly scenic. One is the Wind River Canyon where the Wind-Bighorn River divides the Owl Creek and Bridger Mountains. The other is located along the southeast end of the Pryor Mountains where the deeply incised Bighorn Canyon now holds the waters of the Bighorn Lake. This magnificent canyon was relatively inaccessible before the construction of Yellowtail Dam. Many miles of the canyon's sandstone and limestone cliffs can now be reached by boat.

The major features of the basin are interspersed timbered foothills, dissected lesser plateaus, sharp ridges, rugged badlands, and terraced river valleys. The wide range in erosion resistance of the underlying rock layers is the principal factor in the development of these features. The more resistant rocks stand as erosional remnants or in high relief while the softer rocks have been eroded into open valleys. The precipitous canyons were cut into durable rock over a prolonged period by swift-flowing streams.

Much of the rugged high mountain lands have been designated as wilderness, primitive areas, or roadless areas; but the car-bound tourist can glimpse some of this wonderland on the few roads that traverse the mountains when entering the basin and Yellowstone National Park.

The geologic history of the basin is a complex record of uplift, igneous intrusion, folding, faulting, erosion, and sedimentation. Formations range in age from Precambrian to Quaternary with all the intervening ages except the Silurian being represented. Crystalline rocks of the Precambrian Age are exposed along the high mountain divides, except in the Absaroka Mountains which are composed of volcanic extrusive and intrusive rocks of Tertiary Age. Paleozoic and Mesozoic sedimentary rocks occur around the flanks of the basin. The floor of the basin contains sedimentary rocks of Tertiary Age, and unconsolidated alluvium of Quaternary Age occurs along the river valleys.

1/ The National Atlas of the United States of America, pp. 60-61, USDI, Geological Survey, 1970.

2/ Having a course controlled by the basin's topography.

Several periods of movement of the earth's crust took place in the basin during Precambrian time. This faulting and folding played a major role in determining the present form of the basin. The area was generally quiet during Paleozoic and Mesozoic time. This relatively inactive period ended with the start of the Laramide orogeny which reached its peak in the late Paleocene to early Eocene time. This was closely followed by volcanic activity along the northwest margin of the basin. The basin was then filled with sediments to nearly a plain with only the core of the mountains protruding above the plain. The area was then upwarped and faulted. This caused rejuvenated erosion resulting in canyon cutting and excavation of the basin. Local volcanic activity also occurred at this time. Subsequent alpine glaciation and erosion have modified the basin into its present form. Figure II-3 is a generalized geology map of the basin.

MINERAL RESOURCES

Petroleum, natural gas, uranium, iron, bentonite, gypsum, clay, sand, gravel, limestone, and sulfur are presently the most important mineral resources in the basin. Current annual oil and natural gas production is about 70 million barrels of oil and about 75 billion cubic feet of natural gas from fields scattered throughout the basin. About 2,000,000 tons of uranium ore are processed annually, primarily in the Gas Hills area in the southeast part of the basin. An iron mill on the basin boundary southwest of Lander processes about 4,000,000 tons of raw iron ore per year. About 875,000 tons of bentonite are produced annually in the Greybull area. About 350,000 tons of gypsum per year are produced near Cody and Lovell. Clay is processed for tile in the Lovell area, limestone is quarried near Warren, and feldspar is being mined on Copper Mountain near Boysen Reservoir. Sands and gravels for concrete are produced at several locations in the basin.

Other minerals are available in the basin. Significant reserves of good grade bituminous coal occur, but development is limited to small amounts for local use. Increased development is not expected in the near future because of the abundance of more easily mined coal in adjacent river basins to the east. Large deposits of low grade chromite exist in southern Stillwater County. These were mined during World War II, but the chromium ore cannot presently be produced as economically as it can be imported. Copper, nickel, and platinum are associated with these deposits. Gold, silver, and lead are also found in the basin. Sandstone of building quality is available.

LAND RESOURCES

Land is one of the basic resources used by man and is the most common resource in private ownership. The value of land for agricultural use varies with its productive capacity. This potential capacity is dictated by soils type, climate, vegetative cover, and, in this semiarid

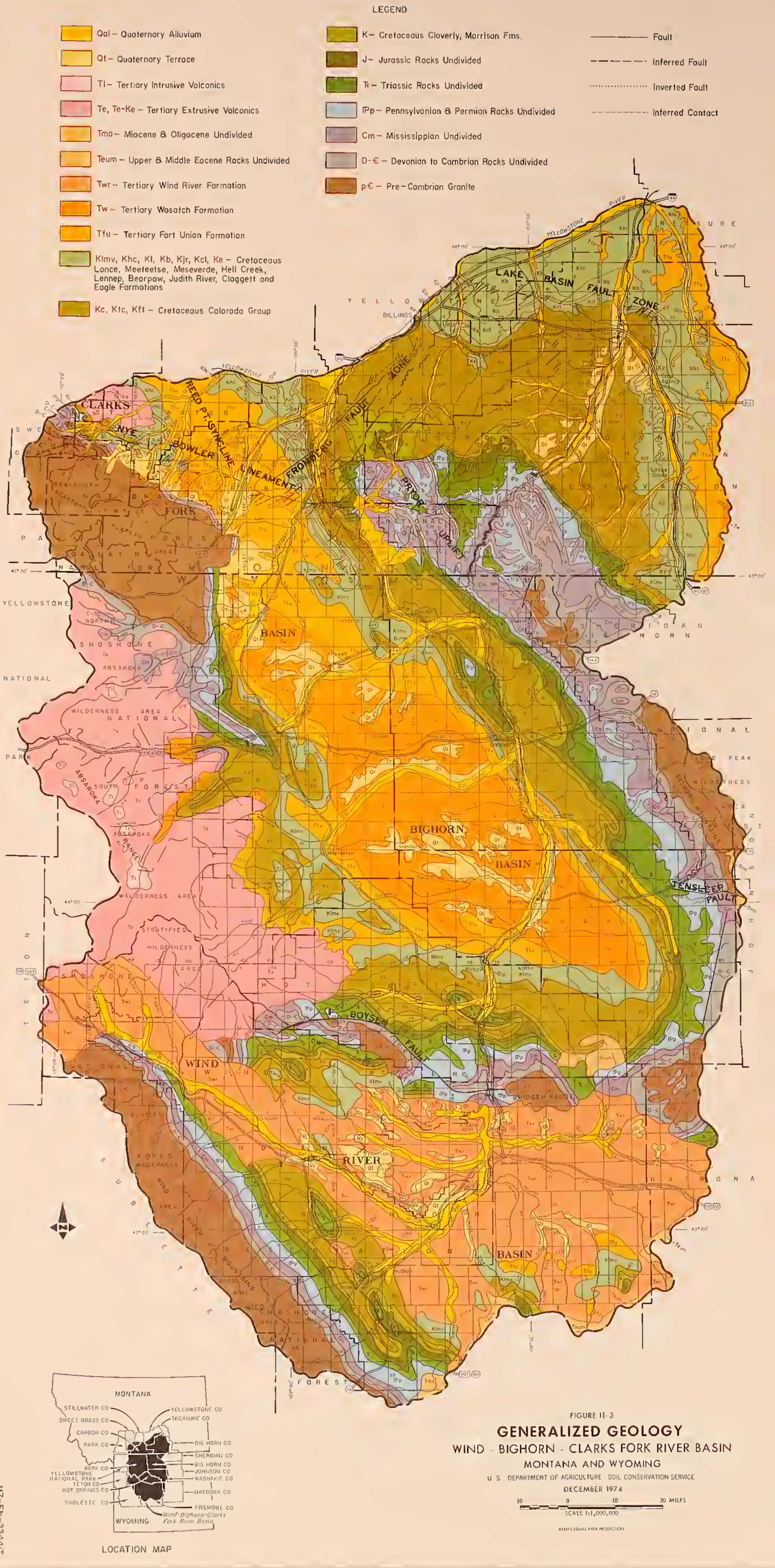


FIGURE II-3
GENERALIZED GEOLOGY
WIND - BIGHORN - CLARKS FORK RIVER BASIN
MONTANA AND WYOMING
U S DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
DECEMBER 1974
SCALE 1:1,000,000

area, the availability of water. Land ownership, soils, vegetative cover, and land use are described in this section.

Land ownership and administration

The ownership and administration pattern of land in the basin has a considerable effect on land resource development. Table II-2 lists major areas of land ownership in the basin. Figures II-4A and II-4B are land ownership and administration maps for the Montana and Wyoming portions of the basin. Nearly half of the area is in federal ownership and administration. Twenty percent of the area is in national forests, and 26 percent of the area is in range and forest lands administered by the Bureau of Land Management. About 38 percent of the land classified as private in this report is Indian trust land in the Wind River and Crow Indian Reservations. The comparison of this with other private ownership is deceptive, however, because much of the reservation land is of the type that otherwise would be national forests and public rangelands. Only about 10 percent of the irrigated cropland in the basin has been developed on reservation lands. Much of the national forest is in wilderness, primitive, or roadless areas.

Soils

The wide variety of soils in the basin is due to the several kinds and origins of the parent materials, to variations in climatic conditions, and the effects of different kinds of vegetation. Soils in the basin have been grouped into generalized associations shown on the generalized soil map of figure II-5.

Vegetative cover

Vegetative cover is described here in terms of vegetative aspect. This is defined as the visually dominant kind of vegetation in a vegetated area, such as grass, brush, trees, irrigated crops, nonirrigated crops, or alpine vegetation. Barren areas, water surfaces, and urban and built-up areas were also included in this inventory. Figure II-6 is a map of vegetative aspects in the basin.

Table II-3 lists areas of vegetative aspect and land use. More than 70 percent of the basin area is brush and grassland. About 15 percent of the area is in trees and about 6 percent in cropland. The rest of the area is in water, alpine areas, barren lands, and urban and built-up areas.

Land use

Land use is influenced by vegetation, climate, soils, ownership, and availability of water. Major land uses are described briefly here. Additional detailed information is found in chapter III.

Irrigated cropland

There are about 770,250 acres of irrigated cropland in the basin.

Table II-2--Surface ownership and administration in the Wind-Bighorn-Clarks Fork River Basin, January 1972[1/]

State	Ownership or administration							
	Private		State		Federal			
	Private ownership	Indian trust lands	Game and Fish Commissions	Other state	Bureau of Land Management	National forest	Bureau of Reclamation	Other federal agencies
	acres		acres		acres			
Wyoming	2,702,660	1,953,100[2/]	19,960	584,340	4,426,150	3,025,590	412,350	54,890
Montana	2,491,530	1,464,800	1,170	122,480	215,030	659,190	10,920	23,830
Total	5,194,190	3,417,900	21,130	706,820	4,641,180	3,684,780	423,270	78,720
Percent of total	29	19	* [3/]	4	26	20	2	*
Total by classification		8,612,090		727,950				8,827,950
Percent by classification		48		4				48

1/ Includes water and total land area.

2/ This may include some land in private non-Indian ownership. The BIA data for this area is 1,885,080 acres.

3/ * means less than 0.5 percent.

Compiled from area measurements on maps and data from land adminstering agencies.

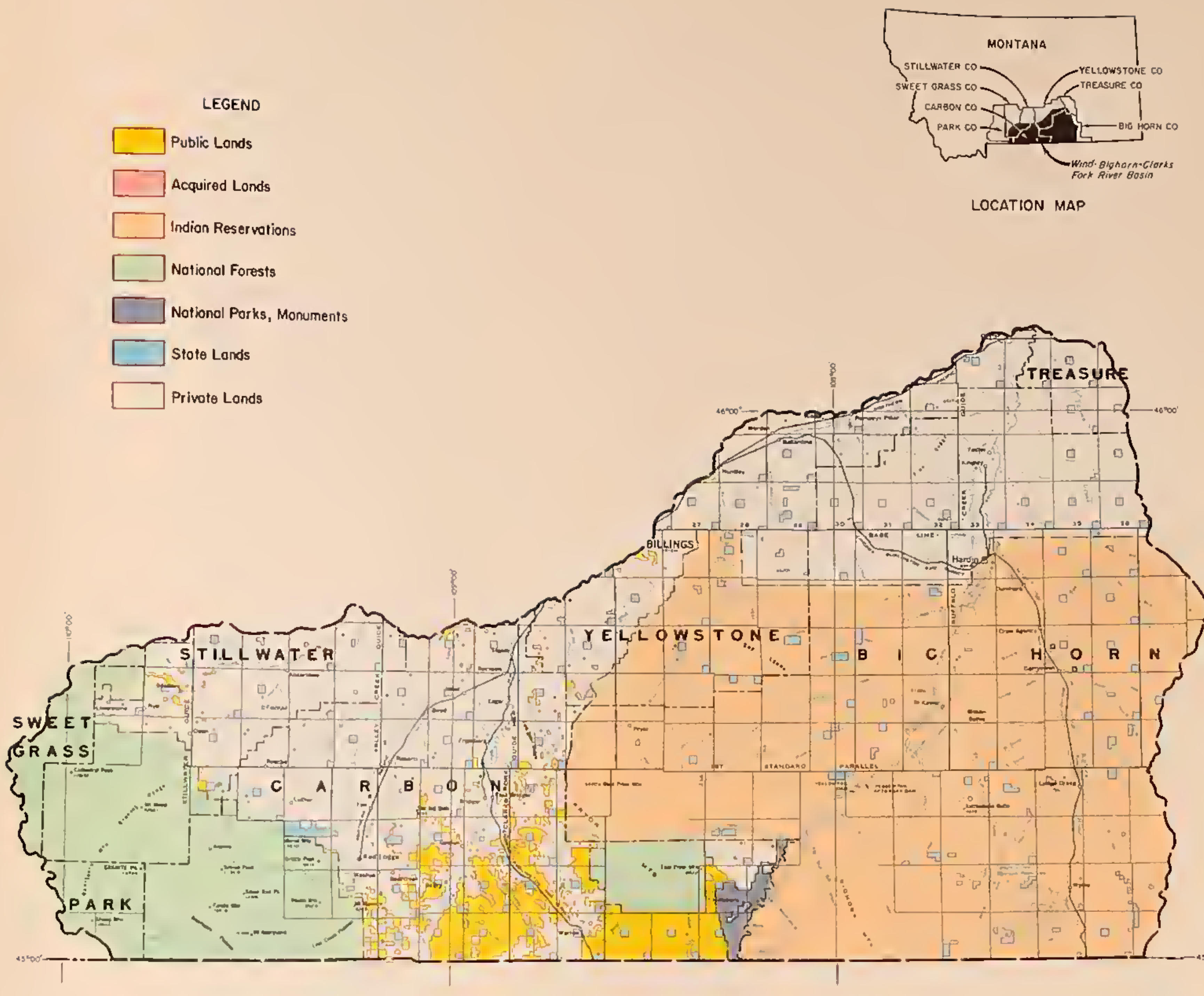


FIGURE II-4A

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA

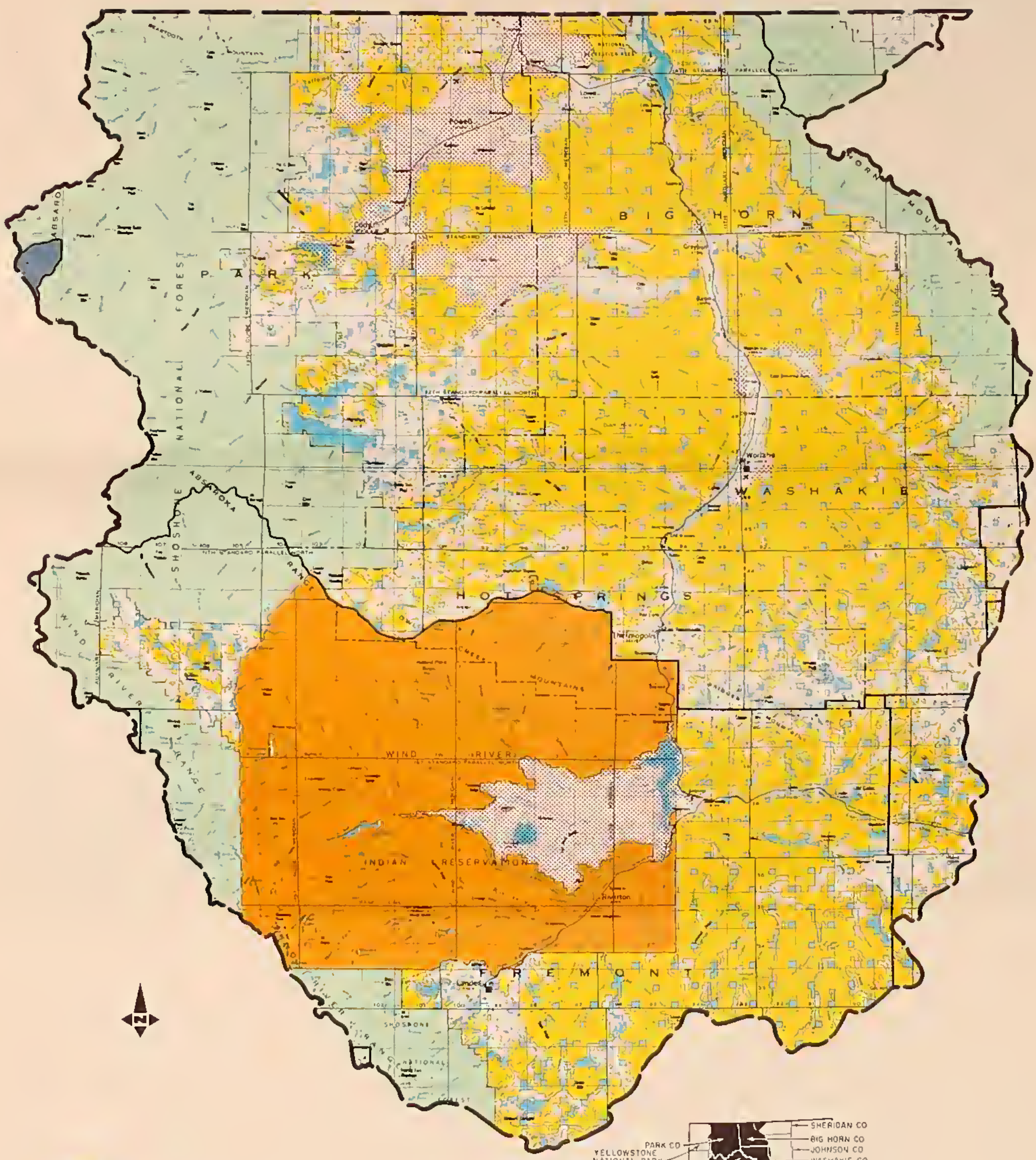
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

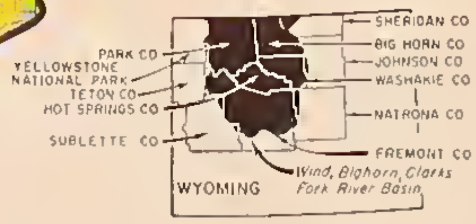
10 0 10 20 MILES

SCALE 1:1,000,000

M7-EN-22441E



Public Lands
National Parks and Monuments
B. L. M. Aquired Land
Indian Reservation
State Lands
Private Lands
National Forests
Bureau of Reclamation Jurisdiction
Prior Mountain Wild Horse and Wildlife Range
National Recreation Areas



LOCATION MAP

FIGURE II-4B

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

From map by Bureau of Land Management

M7-N-22441E

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

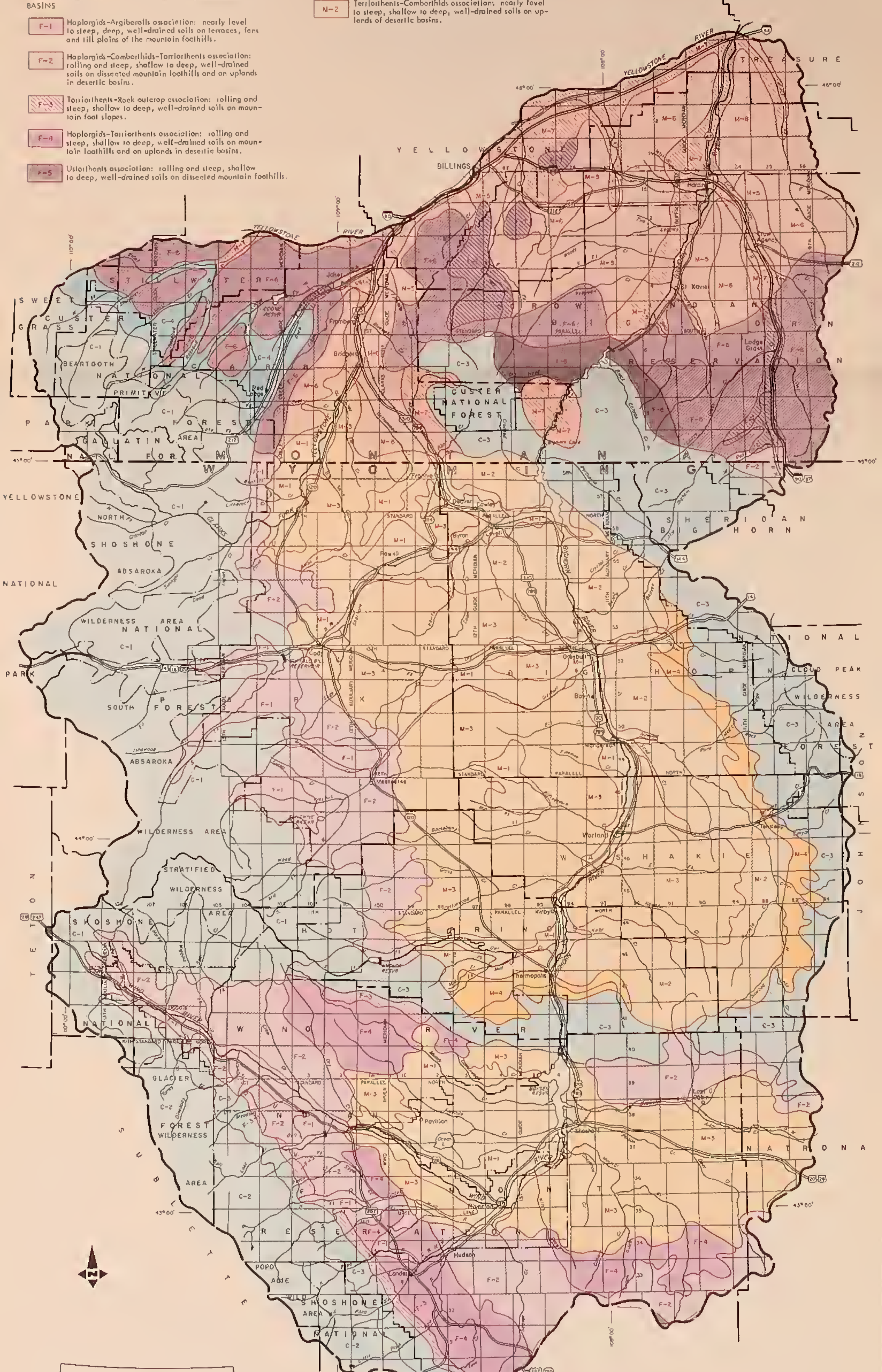
- C-1 Cryoborolls-Cryoboralfs-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.
- C-2 Cryoboralfs-Rock outcrop association: steep and very steep, shallow to deep, well-drained soils on sides and foothills of mountains.
- C-3 Cryoborolls-Rock outcrop association: steep, shallow to deep, well-drained soils on dissected mountain fronts and rounded knolls and ridges of mountains.
- C-4 Cryorthents-Cryoborolls association: nearly level to steep, shallow to deep, well-drained soils on terraces and fans in valleys and on dissected uplands of the mountains.

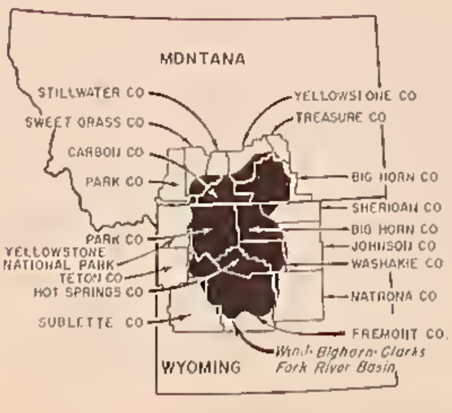
SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

- F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.
- F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.
- F-3 Torriorthents-Rock outcrop association: rolling and steep, shallow to deep, well-drained soils on mountain foot slopes.
- F-4 Haplargids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on mountain foothills and on uplands in desertic basins.
- F-5 Ustorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills.
- F-6 Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills.
- F-7 Ustifluvents-Argiborolls-Haploborolls association: nearly level to rolling, deep, well and moderately well-drained soils on flood plains, terraces and fans on mountain foothills.
- F-8 Ustorthents-Argiborolls association: rolling and steep, shallow to deep, well-drained soils on mountain foothills.
- F-9 Haplargids association: nearly level to rolling, deep, well-drained soils on terraces and uplands of desertic basins.

SOILS OF THE DESERTIC BASINS AND UPLANDS

- M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.
- M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.
- M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.
- M-4 Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected uplands in desertic basins.
- M-5 Torriorthents association: nearly level to steep, shallow to deep, well-drained soils on uplands.
- M-6 Haplargids-Torriorthents-Argiustolls association: nearly level to very steep, shallow to deep, well-drained soils on dissected uplands.
- M-7 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on flood plains, terraces and fans in uplands.





LOCATION MAP

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

FIGURE II-5

GENERALIZED SOIL MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

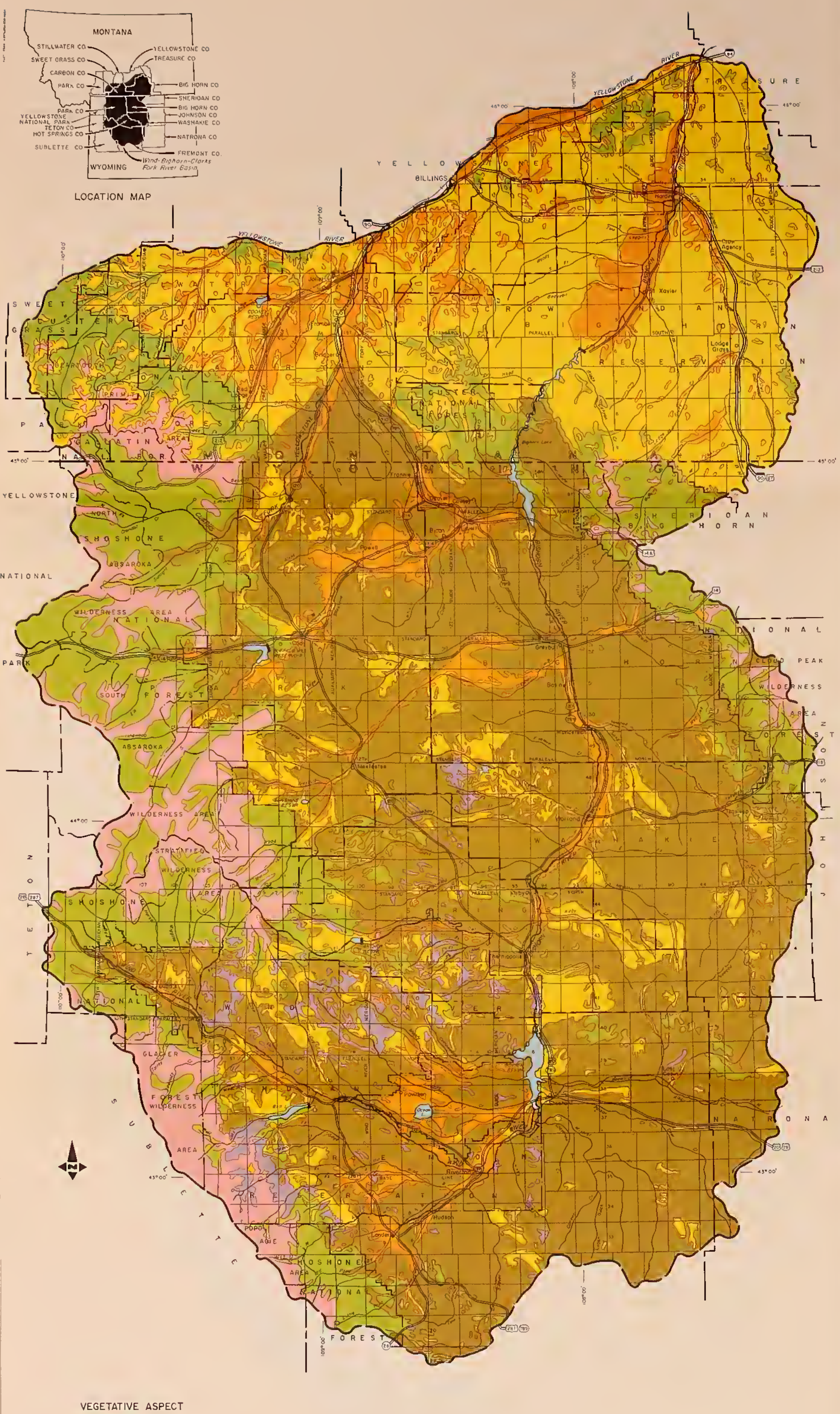
DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-EN-22441D



VEGETATIVE ASPECT

- Alpine
- Barren
- Brush
- Crop
- Grass
- Trees
- Water

FIGURE II-6

VEGETATIVE ASPECT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

M7-EN-22441F

Table II-3—Vegetative aspect and land use by sub-basin and states in the Wind-Bighorn-Clarks Fork River Basin

Sub-basin name	Water	Grass	Irrigated cropland	Non-irrigated cropland	Trees	Brush	Alpine and barren	Urban and built-up	Total
	acres								
Wind River	38,890	428,740	195,770	0	676,460	2,904,050	748,040	790	4,992,740
Bighorn River in Wyoming	28,480	1,362,210	329,500	0	951,250	4,259,530	261,760	3,330	7,196,060
Bighorn River in Montana	12,970	1,308,180	56,460	95,940	202,510	76,020	1,690	9,240	1,763,010
Subtotal for Bighorn River	41,450	2,670,390	385,960	95,940	1,153,760	4,335,550	263,450	12,570	8,959,070
Clarks Fork River in Wyoming	2,880	255,240	11,120	0	235,310	231,380	60,640	0	796,570
Clarks Fork River in Montana	9,530	459,520	88,630	75,490	105,000	171,980	54,840	11,340	976,330
Subtotal for Clarks Fork River	12,410	714,760	99,750	75,490	340,310	403,360	115,480	11,340	1,772,900
Little Bighorn in Wyoming	50	36,510	2,440	4,070	107,860	38,580	4,150	10	193,670
Little Bighorn in Montana	1,400	499,720	17,130	49,680	59,170	0	3,390	7,230	637,720
Subtotal for Little Bighorn	1,450	536,230	19,570	53,750	167,030	38,580	7,540	7,240	831,390
Stillwater River	3,960	373,340	29,250	19,820	212,080	0	33,700	4,530	676,680
Yellowstone minor drainages	2,020	668,350	39,950	103,630	110,260	0	0	11,000	935,210
Total Wyoming	70,300	2,082,700	538,830	4,070	1,970,880	7,433,540	1,074,590	4,130	13,179,040
Total Montana	29,880	3,309,110	231,420	344,560	689,020	248,000	93,620	43,340	4,988,950
Total river basin	100,180	5,391,810	770,250	348,630	2,659,900	7,681,540	1,168,210	47,470	18,167,990
Percent of total	1	30	4	2	15	42	6	0	100

These have been inventoried according to water supply, water delivery system, and common management practices into five types. Type I irrigated croplands have well developed systems, water supply, and water management practices and, therefore, generally produce the higher valued crops in the basin. Type II lands use systems similar to type I lands, but the systems are less well developed. Water supplies are generally short during much of the irrigation season. The systems are often designed for recycling tailwater flows, but on-field application efficiencies are quite low. Type III lands are commonly called mountain meadows. The systems are designed to take high rates of flow during the spring snowmelt season, but the lands are often short of water late in the growing season. Field application efficiencies are low. Type IV lands have special waterspreading systems. Dikes are often used in conjunction with large delivery ditches to divert, pond, and release flood flows whenever they occur during the year. In some years there may be no irrigation at all. Type V irrigated lands receive water only incidentally as a result of the irrigation of other lands. The vegetation is mainly grass used for hay and pasture. They have no irrigation systems and no significant irrigation water management. No type V lands were inventoried in the Montana portion of the basin. Table II-4 lists areas of irrigated cropland by type. Nearly all irrigated cropland in the basin is privately owned, including that portion within Indian Reservation boundaries.

Table II-4--Irrigated lands by type of irrigation, 1970

Sub-basin name	Type					
	I	II	III	IV	V	Total
	acres					
Wind River	73,160	91,060	5,660	7,320	18,570	195,770
Bighorn River in Wyoming	155,720	150,900	2,800	13,670	6,410	329,500
Bighorn River in Montana	34,910	19,660	1,660	230	0	56,460
Subtotal for Bighorn River	190,630	170,560	4,460	13,900	6,410	385,960
Clarks Fork River in Wyoming	2,700	5,350	1,960	1,110	0	11,120
Clarks Fork River in Montana	49,970	38,620	40	0	0	88,630
Subtotal for Clarks Fork River	52,670	43,970	2,000	1,110	0	99,750
Little Bighorn in Wyoming	0	1,190	800	450	0	2,440
Little Bighorn in Montana	3,680	13,310	140	0	0	17,130
Subtotal for Little Bighorn	3,680	14,500	940	450	0	19,570
Stillwater River	1,500	19,560	8,190	0	0	29,250
Yellowstone minor drainages	24,380	15,220	120	230	0	39,950
Total Wyoming	231,580	248,500	11,220	22,550	24,980	538,830
Total Montana	114,440	106,370	10,150	460	0	231,420
Total river basin	346,020	354,870	21,370	23,010	24,980	770,250
Percent of total	45	46	3	3	3	100

Soil scientists obtain basic soils information.

Knowledge about his soil is essential to the successful rancher.

PLATE 3

Surface water from mountain snowmelt is diverted in the summer to irrigate croplands.

Grass or brushland range is the most extensive land use in the basin.

Forest land is defined as land at least 10 percent stocked by trees of any size.

U.S. FOREST SERVICE PHOTO

Nonirrigated croplands

There are only about 4,070 acres of nonirrigated cropland in the Wyoming portion of the basin. All of these lands are in the northeast corner of the basin. There are about 344,560 acres in the Montana portion of the basin. This represents 60 percent of the total cropland in this area. (See table II-3.) Grains are the most important crops on these lands, but nearly half of this land is fallow each year. This rotation is required to build up the soil moisture needed to raise the crops.

Rangeland

Most of the brush and grass lands and some of the land with trees is used for livestock grazing and is considered rangeland. The privately-owned portion is used and managed for this primary purpose. The publicly-owned portion is usually leased for grazing and managed for multiple uses. Range condition is an indicator of production at a given location. Range conditions on private grass and brush lands are about 20 percent excellent, 55 percent good, 20 percent fair, and 5 percent poor. Production varies between locations because of precipitation, growing season, soils, and management. Much of the rangeland in the basin is low in production because of low precipitation, poor seasonal distribution of precipitation, and short growing season.

Forest land

In this report, forest land is not defined as land with trees. Forest land is land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, lands from which trees have been removed to less than 10 percent stocking which have not been developed for other uses are still defined as forest lands. Table II-5 lists areas of commercial and noncommercial forest land by stand size class and ownership. A comparison with table II-3 shows that in Montana there are more tree-covered lands than forest lands. In Wyoming there are more forest lands than tree-covered lands.

Commercial forest land is land which is producing, or is capable of producing, an economically usable harvest of wood (usually at least 20 cu. ft./acre/yr.) and is not withdrawn or reserved from cutting. There are about 1,444,470 acres of commercial forest land in the basin. About 76 percent of this is in national forests. About 87 percent of the area has timber larger than 5 inches in diameter and suitable for poles or sawtimber. About 11 percent of the area has trees classified as seedlings and saplings. However, much of the small timber, including poletimber, is comprised of stagnated stands. These stands are relatively old and will not grow significantly even if thinned. These are softwood forests, and the use of timber does not depend on the species available to a significant degree.

Table II-5--Forested land area by stand size class and ownership, 1971 1/

	Total area			National forest		Public domain		Indian reservation		State and private		Yellowstone National Park
	Basin	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	Wyoming	Montana	(Wyoming)
Commercial forest												
Sawtimber	824,980	719,900	105,080	475,200	53,270	15,600	0	33,000	21,050	196,100	30,760	0
Poletimber	429,780	364,500	65,280	361,000	42,450	3,500	0	2/	2,620	N/A 3/	20,210	0
Seedlings and saplings	165,410	66,100	99,310	61,000	82,610	100	0	5,000	290	N/A	16,410	0
Nonstocked	23,000	23,000	0	23,000	0	0	0	N/A	0	N/A	0	0
Unclassified commercial	1,300	0	1,300	0	0	0	1,300	0	0	0	0	0
Subtotal - commercial	1,444,470	1,173,500	270,970	920,200	178,330	19,200	1,300	38,000	23,960	196,100	67,380	0
Noncommercial and reserved 4/	1,473,420	1,128,200	345,220	795,800	126,690	1,000	7,900	169,000	53,650	144,200	156,980	18,200
Total forested land	2,917,890	2,301,700	616,190	1,716,000	305,020	20,200	9,200	207,000	77,610	340,300	224,360	18,200

1/ See text for definition of forested land.

2/ Poletimber area included in sawtimber area on the reservation.

3/ N/A means data is not available.

4/ Stand size class not available for noncommercial and reserved forest land. Reserved areas include designated wilderness and primitive areas.

Other lands

About 6 percent of the basin is in barren, alpine, or urban and built-up areas. Most, if not all, of the alpine areas are in designated wilderness or primitive areas at elevations about 10,000 feet. They are very important as water yielding areas and some are covered with glaciers. The vegetation is either taiga or tundra. Barren lands at lower elevations lack vegetation primarily because of poor soils associated with natural geologic erosion. Urban and built-up areas include cities, towns, highways, roads, railroads, farmsteads, and other incidental land uses and include less than 0.3 percent of the total basin. Water areas listed in table II-3 include ponds, lakes, and reservoirs as small as 5 acres in size.

SURFACE WATER RESOURCES

Surface water supplies

Water resources available for use in the basin depend largely on the melting of high country snowpacks. Rainstorms in the basin and snowmelt from lower elevation lands also contribute to the total supply. Water yield to surface streams ranges from almost zero in some years at low elevations to more than 2,700 acre-feet per square mile per year (50 inches) from some high elevation lands. Figure II-7 is an average water yield map for the basin as developed in this study.

The seasonal distribution of streamflows is an important factor in its effect on the environment and the use of the water supply. Figure II-8 is a typical annual stream hydrograph for a stream with relatively little regulation. More water is available in the spring that can generally be used through direct diversion, and high waters in the spring sometimes cause flooding on lowlands along the streams. Streamflows decrease rapidly as the snowpack is depleted. There is generally a water supply deficit in late summer and early fall. Reservoirs reduce this effect by storing spring runoff for late summer use.

Table II-6 lists estimated annual streamflows at several locations in the basin for 50 percent and 80 percent chance years. The flow available in a 50 percent chance year is equaled or exceeded about 50 of each 100 years. The flow available in an 80 percent chance year is a smaller but more reliable flow exceeded about 80 of each 100 years. These data were obtained through analysis of stream gaging records supplemented by a river basin simulation computer model. Irrigation and phreatophyte depletion estimates are based on field and aerial photograph surveys of area and the modified Blaney-Criddle method of estimating consumptive use.

As you can see from table II-6, 26 percent or more of the total native water supply is depleted by irrigation in dry years. The impact of irrigation is even greater than this depletion estimate indicates. More than 50 percent of the total water supply is diverted for irrigation use. Practically all of the surface water resource is affected in some way by irrigation.

Table II-6--Estimated surface water resources of the Wind-Bighorn-Clarks Fork River Basin, 1970

Sub-basin	Phreato-phyte area	Present area of irrigated land	50 percent chance: Total native water yield	50 percent chance: Flow from upstream sources or transfers 1/	50 percent chance: Phreato-phyte depletion	50 percent chance: Reservoir effects and evaporation	50 percent chance: Available water supply 1/	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply 1/	80 percent chance: Total native water yield	80 percent chance: Flow from upstream sources or transfers 1/	80 percent chance: Phreato-phyte depletion	80 percent chance: Reservoir effects and evaporation	80 percent chance: Available water supply 1/	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply 1/
	acres	acres	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet
Wind River	76,020	195,769	1,492,200	0	148,200	82,800 2/	1,261,200	336,200	925,000	1,207,300	0	142,000	2,500 3/	1,062,800	322,800	740,000
Bighorn River in Wyoming	119,370	329,503	2,353,740	954,960	213,600	22,000 4/	3,073,100	677,100	2,396,000	1,939,270	759,930	203,600	22,000 3/	2,473,600	646,600	1,827,000
Little Bighorn in Wyoming	0	2,441	141,000	0	0	0	141,000	2,700	138,300	113,500	0	0	0	113,500	2,300	111,200
Little Bighorn in Montana	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
Bighorn River in Montana	10,550	56,454	164,920	2,570,150	66,690	26,000 5/	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000 5/	1,938,380	87,380	1,851,000
Upper Clarks Fork in Montana	2,240	0	237,460	0	6,760	0	230,700	0	230,700	195,960	0	6,760	0	189,200	0	189,200
Clarks Fork River in Wyoming	3,010	11,119	458,100	230,700	7,700	0	681,100	21,100	660,000	399,500	139,200	7,700	0	581,000	21,000	560,000
Upper Rock Creek, Big Sand Coulee, and Elk Basin	0	0	36,500	16,700 6/	0	0	53,200	0	53,200	29,500	24,510 6/	0	0	54,010	0	54.010
Lower Clarks Fork in Montana	13,170	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930	273,760	614,010	69,070	2,400	816,300	140,070	676,230
Stillwater River	4,760	29,252	850,400	0	18,760	0	831,640	63,500	768,140	701,380	0	18,760	0	682,620	71,310	611,310
Yellowstone minor drainages	3,790	39,951	98,630	4,813,930 7/	25,260	0	4,887,300	63,930	4,823,370 7/	69,560	4,076,230 7/	25,260	0	4,120,530	63,930	4,056,600 7/

1/ The data in these columns are for the sub-basins named and are not additive to obtain basinwide totals.
2/ Includes carryover storage in Boysen Reservoir as indicated by streamflow records from 1951 - 1970.
3/ Withdrawals from storage in dry years replaces some other losses as indicated by streamflow records from 1951 - 1970.
4/ Primarily evaporation from Buffalo Bill Reservoir.
5/ Primarily evaporation from Bighorn Lake.
6/ Diversion from Rock Creek.
7/ Includes the flow of the Yellowstone and Clarks Fork Rivers. Most of this flow is not diverted for irrigation, but is available for phreatophytes in watersheds along the Yellowstone River. These flows and the flow from the Bighorn River constitute most of the available water in the Yellowstone River at Bighorn, Montana.

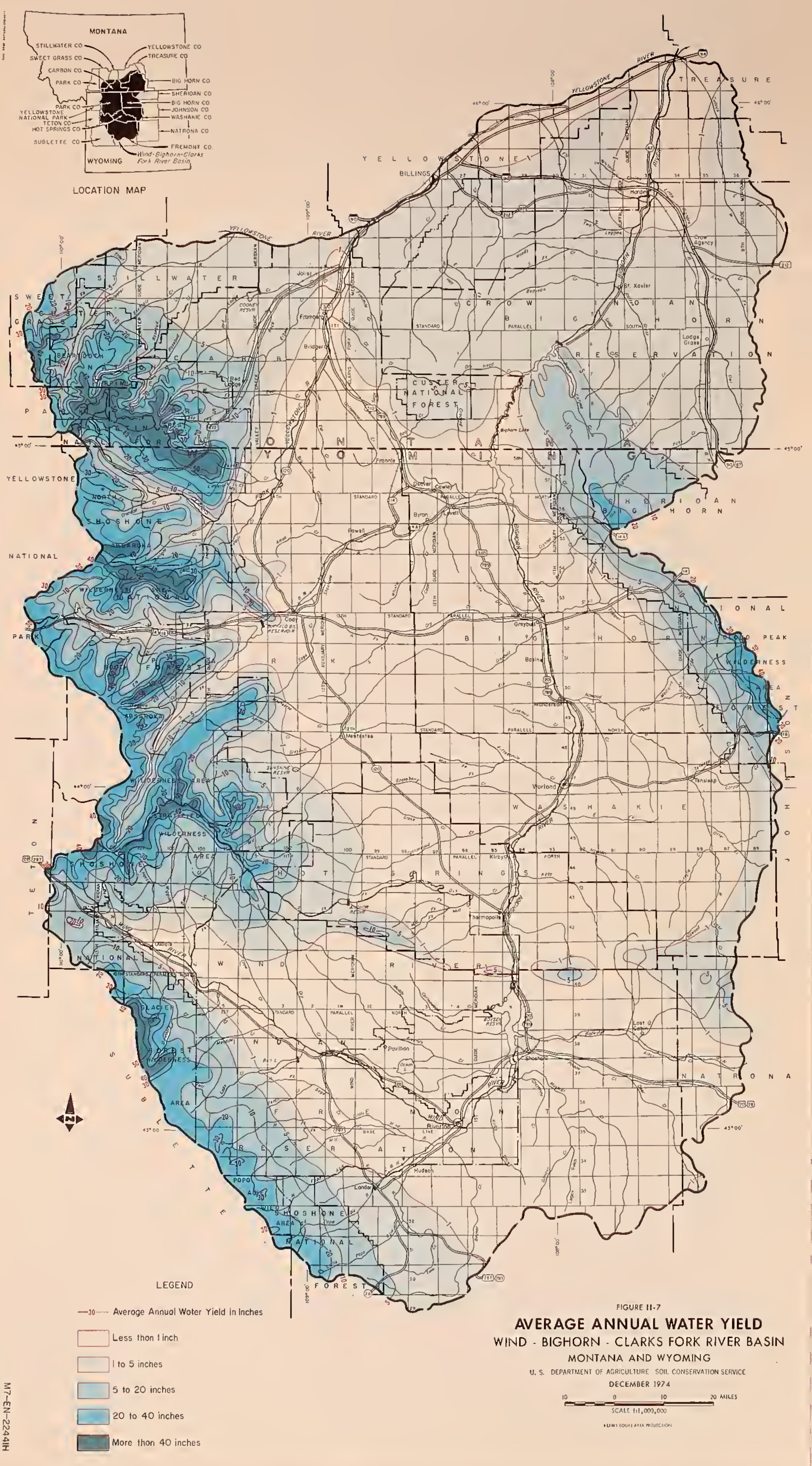


FIGURE II-7
AVERAGE ANNUAL WATER YIELD
WIND - BIGHORN - CLARKS FORK RIVER BASIN
MONTANA AND WYOMING
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
DECEMBER 1974

M7-EN-22441H

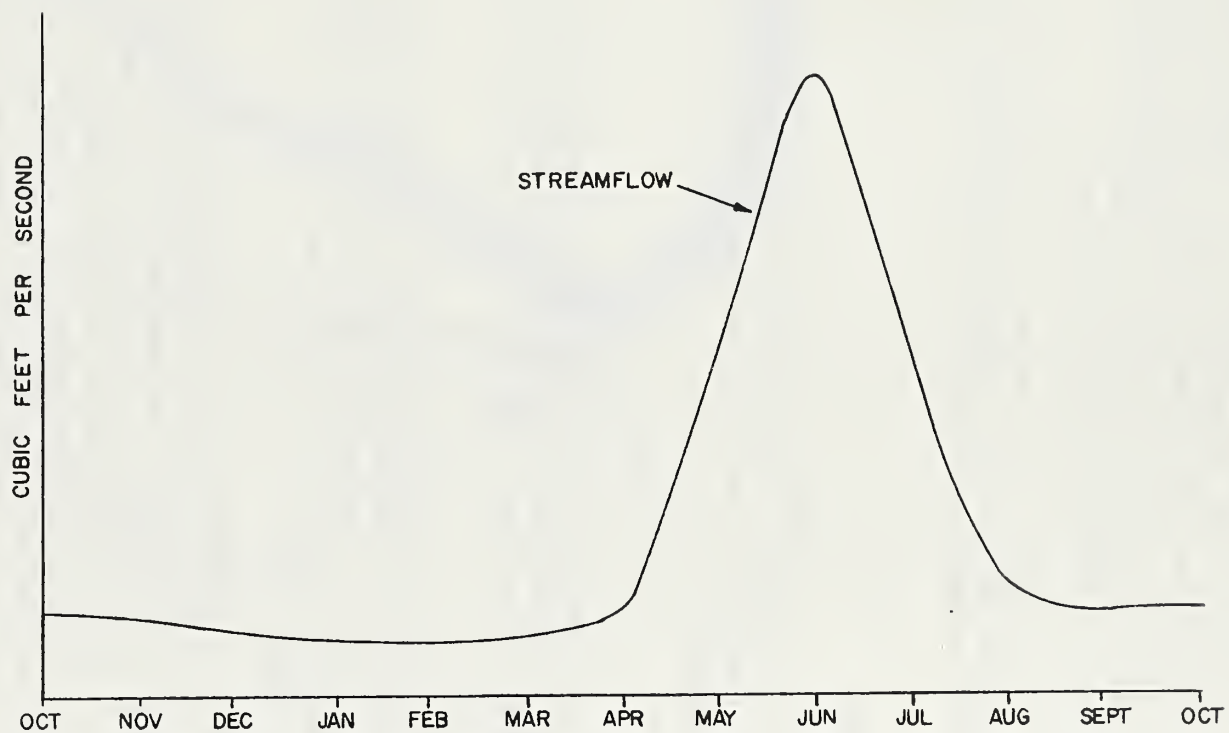


FIGURE II-8 -- TYPICAL ANNUAL STREAMFLOW HYDROGRAPH

About 10 percent of the surface water in the basin is depleted by phreatophytes. No discussion of the water resources of the basin can omit these uses.

This basin is a water surplus area in spite of important water shortages within the basin. The 50 percent chance annual flow of water from this basin to the Missouri River Basin system is about 4,200,000 acre-feet. About 70 percent is contributed from Wyoming, which has 72 percent of the basin area. Figure II-9 is a flow chart of the surface waters of the basin for a 50 percent chance water year.

The quality of the surface water resource is probably less than it was before the 19th century, but is still adequate for most uses in most parts of the basin. More discussion on water quality can be found at the end of this chapter.

Water surface areas

The free surface of open water is also a resource and is essential for many recreational activities. Table II-7 lists surface areas of lakes and ponds of more than 5 acres and total lengths of live streams and rivers in major subbasins.

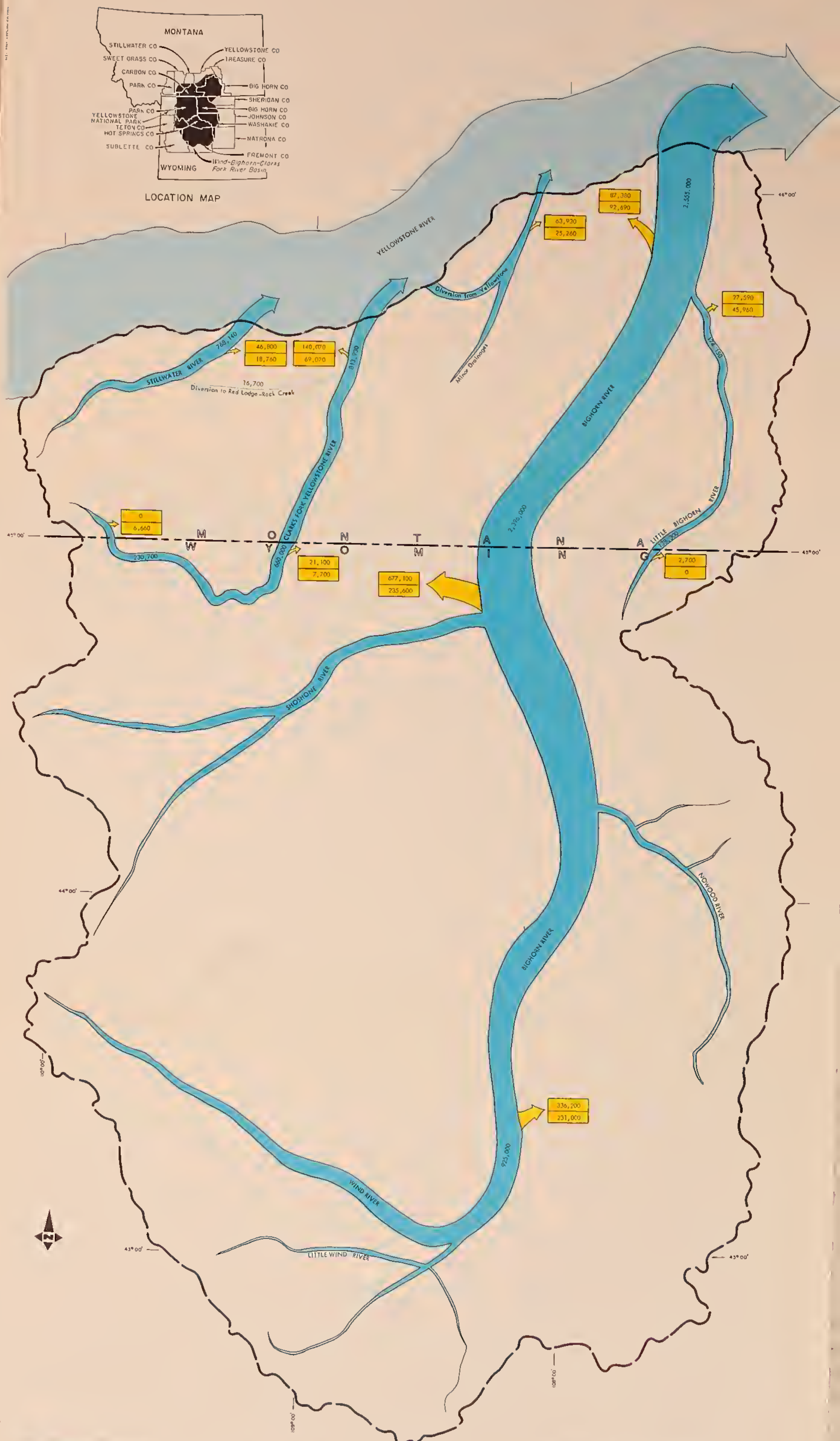
Glaciers

Glaciers in the Wyoming portion of the basin have a surface area of about 15 square miles. The Glacier Primitive Area, encompassing 176,303 acres, contains many of the area's glaciers, but others exist northward to the Clarks Fork River.

These glaciers are known as temperate glaciers and characteristically have a temperature of 32° F. throughout the pack, except during very cold weather. Temperate glaciers can produce much runoff. The estimated annual streamflow is 9 acre-feet per acre of glacier surface or 86,400 acre-feet for the entire 15 square miles.

The major agent of accumulation is snow that gradually changes into ice. Ablation, or loss of mass, occurs on temperate glaciers predominantly from melting. There is also loss from evaporation and sublimation. The fluctuation of melt water discharge in midsummer is pronounced, and the release is closely related to the amount of energy supplied by the sun and atmosphere. However, the correlation between daily temperatures and daily streamflows is not satisfactory. Further, the yearly total runoff does not necessarily equal the sum of precipitation plus condensation minus evaporation. The changes in both short and long-term trends relate to changes in storage. Cool, wet years favor accumulation and storage, while warm, dry years favor increased runoff.

There are probably ways to artificially modify melt rates from glaciers.



WATER YIELD & DEPLETIONS (acre feet – 50% chance annual yield)

925,000 General water flow pattern of major streams

Mainstem of Yellowstone River

Depletion of flow

336,000 Irrigation depletion amount in acre-feet
731,000 Evaporation, phreatophyte, and other losses in acre-feet

FIGURE II-9

GENERALIZED SURFACE WATER FLOW CHART

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Table II-7--Water surface areas and stream lengths by subbasin

Subbasin	Surface areas of ponds, lakes, and reservoirs	Length of live streams and rivers
	-----acres----	------miles------
Wind River	38,890	1,500
Bighorn River in Wyoming	28,480	4,300
Bighorn River in Montana	12,970	400
Subtotal for Bighorn River	41,450	4,700
Clarks Fork River in Wyoming	2,880	600
Clarks Fork River in Montana	9,530	410
Subtotal for Clarks Fork River	12,410	1,010
Little Bighorn River in Wyoming	50	100
Little Bighorn River in Montana	1,400	170
Subtotal for Little Bighorn	1,450	270
Stillwater River	3,960	340
Yellowstone minor drainages	2,020	130
Total Wyoming	70,300	6,500
Total Montana	29,880	1,450
Total river basin	100,180	7,950

However, artificial management of glaciers is not well developed in practice. Most of the glaciers are in wilderness areas. Natural and political restrictions on the use of motorized vehicles in these areas would likely make artificial management of the glaciers impractical.

GROUND-WATER RESOURCES

The availability of ground water within favorable drilling and pumping depths varies widely in aquifers in the basin. Where good quality ground water is available, it is used for domestic, industrial, irrigation, municipal, and livestock water supplies. Some aquifers hold water under pressure sufficient for artesian flows.

The quality and yield of ground water from a well varies primarily with the type of soil or rock in the aquifer that is tapped. The soil or rock can be identified by geologic formation. Shales are generally not aquifers. Sandstones are capable of moderate yields from 125 to 300 gallons per minute (gpm) or more. The Madison limestones and the Flathead sandstones are capable of large flows where they are cavernous or fractured. One well on Bluewater Creek in Montana flows 3,700 gallons per minute. Moderate yields are obtainable from alluvium formations in many locations. The greatest yields are obtained close to mountains where a greater abundance of coarser sands and gravels are found. Yields average about 300 gpm, but flows up to 2,000 gpm have been reported.

Figure II-10 is a map of the general availability of ground water. It shows the depth within which ground water may be expected. The yield that may be expected and its quality is also described. However, this map is generalized. Every location is geologically different and requires individual determination of the potential for gound water development. At some locations there may also be a serious conflict between ground and surface water rights. Figure II-11 provides references to specific publications which have more detailed ground water information.

FISH AND WILDLIFE RESOURCES

Low human population density, large areas of public lands, and wide variations in climate and vegetative cover contribute to relatively large populations of a wide variety of animal life.

Big game habitat

The habitat for big game ranges from rough alpine peaks and crags to vast grassland or sagebrush plains. Croplands, stream valleys, and deserts combine with the plains and mountain slopes as essential parts of the total area of big game habitat. Table II-8 lists big game species, the areas of their range, and their populations in each state. The condition of big game habitat in the basin is generally good. The most serious big game habitat limitation is winter range. Figure II-12 includes maps of habitat areas for deer, antelope, elk, moose, bighorn sheep, mountain goat, and bear. Mountain lion may also be hunted in some portions of the basin.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450+ gpm	Fair to Good
QUATERNARY			River Terrace	Water Bearing	Less than 50 gpm	Fair to Good
TERTIARY	EOCENE PALEOCENE		Wasatch-Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		*Extrusive Pyroclastics	Non-Water Bearing		
CRETACEOUS	UPPER		Hell Creek Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		Lennep Sandstone	Water Bearing	Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		*Bearpaw Shale	Non-Water Bearing		
CRETACEOUS	UPPER		Judith River Formation	Water Bearing	Less than 50 gpm	Poor to Fair
CRETACEOUS	UPPER		*Claggett Shale	2/ Non-Water Bearing	2/ Less than 50 gpm	Poor to Fair
CRETACEOUS	UPPER		Eagle Sandstone	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER	COLORADO GROUP	Telegraph Creek Formation	Water Bearing	Less than 50 gpm	Fair to Poor
CRETACEOUS	UPPER	COLORADO GROUP	Niobrara Formation	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	*Cody Shale	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	*Carlile Shale	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	*Greenhorn Formation	Non-Water Bearing		
CRETACEOUS	LOWER	COLORADO GROUP	Frontier Formation	Non-Water Bearing		
CRETACEOUS	LOWER	COLORADO GROUP	Frontier, Torchlight Member	Water Bearing	*** Less than 50 gpm	Poor
CRETACEOUS	LOWER	COLORADO GROUP	Belle Fourche Shale	Non-Water Bearing		
CRETACEOUS	LOWER	COLORADO GROUP	*Mowry Shale	Non-Water Bearing		
CRETACEOUS	LOWER	COLORADO GROUP	Muddy Sandstone	Water Bearing	Less than 50 gpm	Poor
CRETACEOUS	LOWER	COLORADO GROUP	*Thermopolis Shale	Non-Water Bearing		
CRETACEOUS	LOWER	COLORADO GROUP	Cloverly Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Morrison Formation	Water Bearing	Less than 50 gpm	Poor to Fair
JURASSIC			Swift Formation	Water Bearing	Less than 50 gpm	Poor to Fair
JURASSIC			Rierdon Formation	Non-Water Bearing		
JURASSIC			Sundance Formation	Water Bearing	Less than 50 gpm	Poor
JURASSIC			*Gypsum Spring-Piper Formation	Non-Water Bearing		
TRIASSIC			*Chugwater Formation	Non-Water Bearing		
TRIASSIC			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone	Water Bearing	*** 50 - 450 gpm	Fair to Good
PENNSYLVANIAN			Amsden Formation	Water Bearing	*** 50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	*** 50 - 450 gpm	Good
DEVONIAN			Jefferson Limestone	Water Bearing	*** Less than 50 gpm	Good
ORDOVICIAN			*Big Horn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	*** Less than 50 gpm	Poor to Fair
CAMBRIAN			Gros Ventre Formation	Non-Water Bearing		
CAMBRIAN			*Flathead Quartzite	Water Bearing	*** 50 - 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

WYOMING PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450 gpm	Fair to Good
TERTIARY	Miocene		Miocene & Oligocene Rocks	Water Bearing Properties Unknown		
TERTIARY	Oligocene		*Intrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Oligocene		Extrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Eocene		Upper & Middle Eocene Rocks	Water Bearing	Less than 50 gpm	Good
TERTIARY	Eocene		Wind River Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Eocene		Wasatch Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Paleocene		Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		Lance & Meeteetse Formation	Water Bearing	Less than 50 gpm	Fair
CRETACEOUS	UPPER		Mesaverde Group	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER	COLORADO GROUP	*Cody Shale	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	Frontier Formation	Water Bearing	*** Less than 50 gpm	Poor
CRETACEOUS	LOWER	COLORADO GROUP	*Mowry & Thermopolis Shales	Non-Water Bearing		
CRETACEOUS	LOWER		Cloverly & Morrison Formations	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Sundance Formation	Water Bearing	*** Less than 50 gpm	Poor
JURASSIC			*Gypsum Spring Formation	Non-Water Bearing		
TRIASSIC			Chugwater Formation	Non-Water Bearing		
TRIASSIC			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN			Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN			*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
CAMBRIAN			Gros Ventre Formation	Non-Water Bearing		
CAMBRIAN			*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

2/ Parkman Sandstone member of Claggett may be water bearing.

TRIASSIC	Chugwater Formation	Non-Water Bearing		
	*Dinwoody Formation	Non-Water Bearing		
PERMIAN	Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN	Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN	Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN	Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN	*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN	Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
	Gros Ventre Formation	Non-Water Bearing		
	*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN	*Metamorphic & Igneous Rocks	Non-Water Bearing		

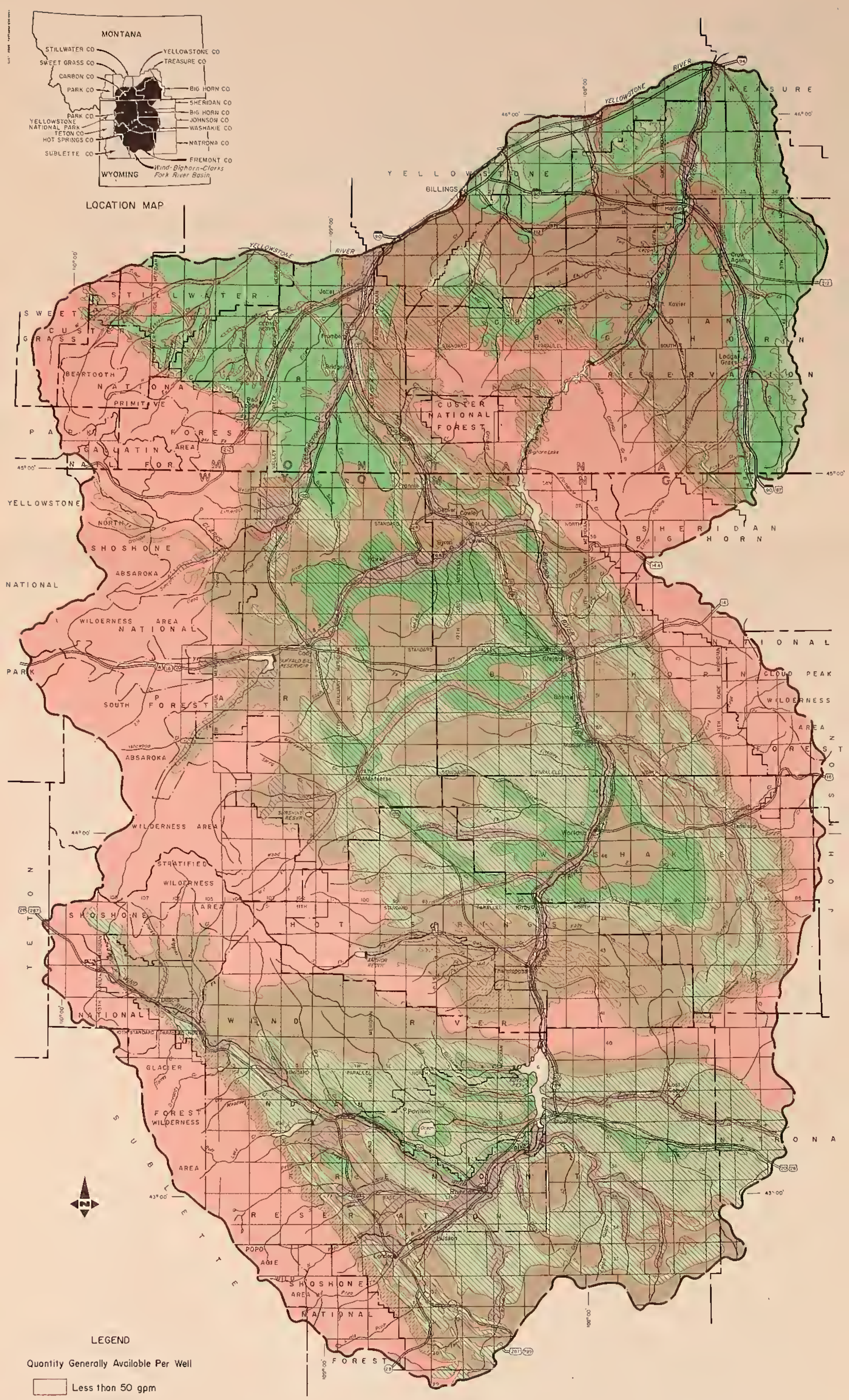
* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

2/ Parkman Sandstone member of Claggett may be water bearing.



LEGEND

Quantity Generally Available Per Well

- Less than 50 gpm
- 50–450 gpm
- More than 450 gpm

Depth Within Which Ground Water May Be Expected

Alluvium

- Less than 100 Feet

Bedrock

- Less than 300 Feet
- 300–600 Feet
- 600–3,500 Feet
- Ground water not generally available

FIGURE II-10

GENERAL AVAILABILITY OF GROUND WATER

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-SN-22441J

FIGURE 11-11

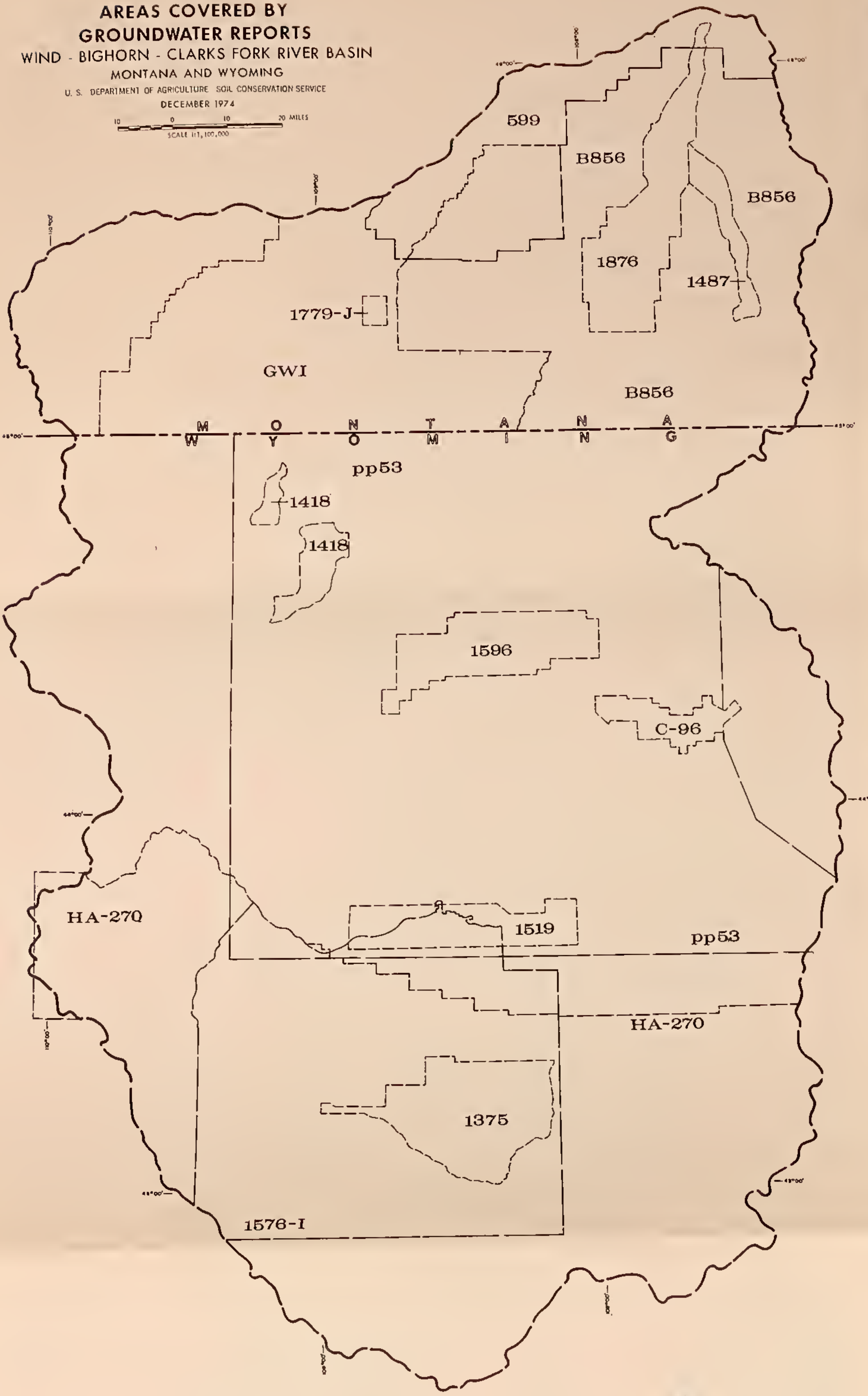
AREAS COVERED BY GROUNDWATER REPORTS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974



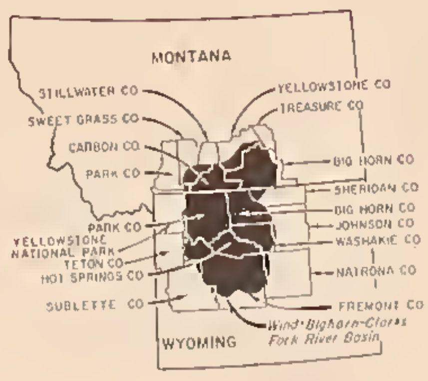
BIBLIOGRAPHY OF GROUND WATER AND RELATED STUDIES

MONTANA

599	USGS Water Supply Paper 599, Ground Water in Yellowstone and Treasure Counties, Montana; G.H. Hall and C.S. Howard, 1929.
B856	USGS Bulletin 856, Geology of Big Horn County and the Crow Indian Reservation, Montana, 1935; W.T. Thom, Jr., G.M. Hall, C.H. Wegemann, and G.F. Moulton.
1487	USGS Water Supply Paper 1487, Geology and Ground Water Resources of the Lower Little Big Horn River Valley, Big Horn County, Montana; E.A. Moulder, M.F. Klug, O.A. Morris and F.A. Swenson, 1960.
1779-J	USGS Water Supply Paper 1779-J, Geology and Water Resources of the Bluewater Springs Area, Carbon County, Montana; E.A. Zimmerman, 1964.
1876	USGS Water Supply Paper 1876, Geology and Ground Water Resources of the Lower Big Horn Valley, Montana; L.J. Hamilton and Q.F. Paulson, 1968.
GWI	Ground Water Inventory, Carbon County, Montana, Montana Water Resources Board, 1969.

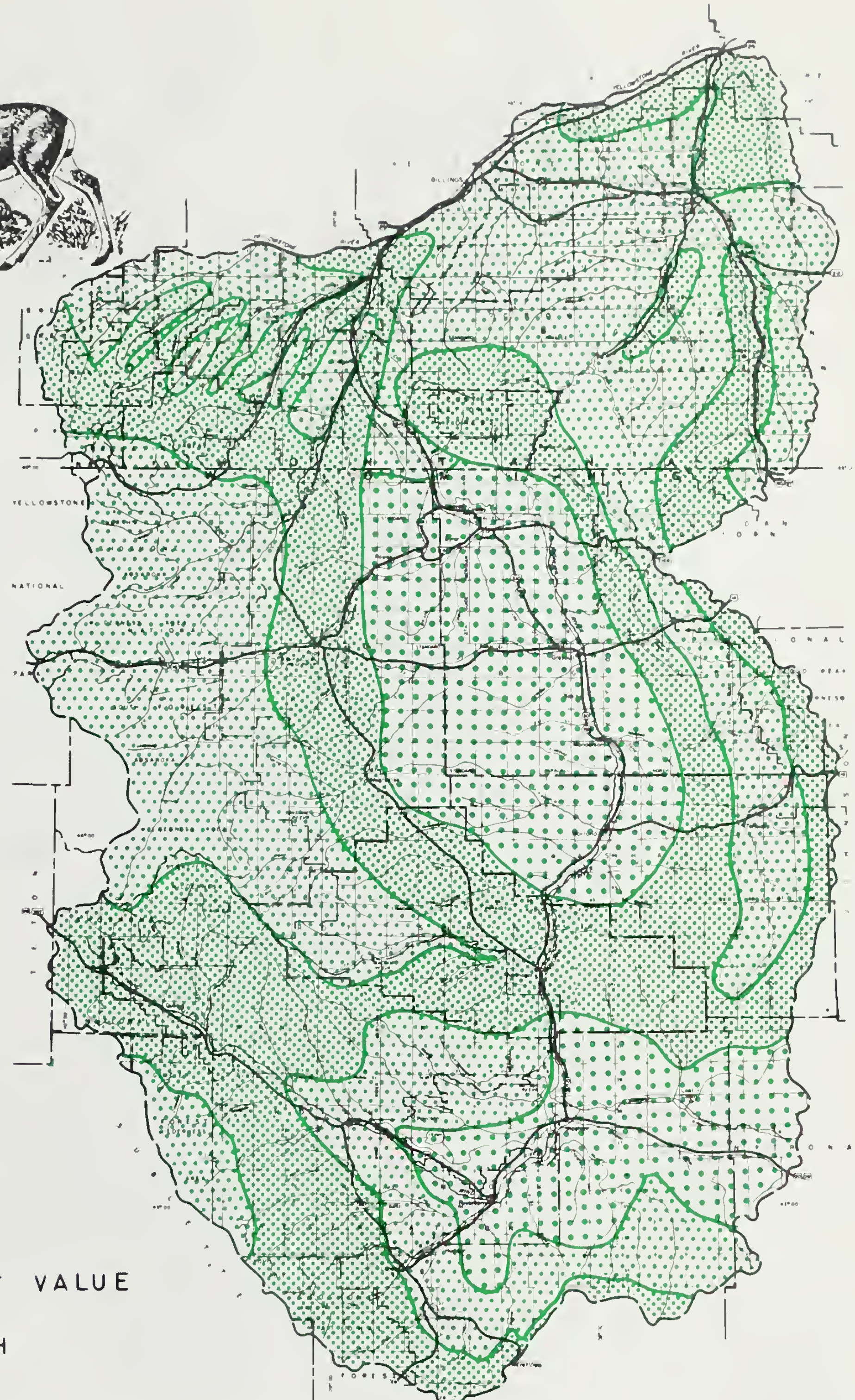
WYOMING

1596	USGS Water Supply Paper 1596, Geology and Ground Water Resources of the Greybull River - Dry Creek Area, Wyoming; C.J. Rabinove and R.H. Langford.
1519	USGS Water Supply Paper 1519, Geology and Ground Water Resources of the Owl Creek Area, Hot Springs County, Wyoming; D.W. Barry and R.T. Littleton.
1418	USGS Water Supply Paper 1418, Geology and Ground Water Heart Mountain and Chapman Bench Divisions, Shoshone Irrigation Project, Wyoming; H.A. Swenson.
1375	USGS Water Supply Paper 1375, Ground Water Resources of Riverton Irrigation Project Area, Wyoming; D.A. Morris, O.M. Hackett, K.E. Vanlier, and E.A. Moulder.
1576-I	USGS Water Supply Paper 1576-I, Ground Water Resources of the Wind River Indian Reservation, Wyoming; L.J. McGreavy, W.G. Hodson, and S.J. Rucker.
pp53	USGS Professional Paper 53, 1906; Geology and Water Resources of the Bighorn Basin, Wyoming; C.A. Fisher.
C-96	USGS Circular 96, Ground Water Resources of the Paintrock Irrigation Project, Wyoming; F.A. Swenson and W.K. Bach.
HA-270	U.S. Geological Hydrologic Atlas 270, Ground Water Resources and Geology of the Wind River Basin Area, Central Wyoming; H.A. Witcomb and M.E. Lowry.



LOCATION MAP

M7-EN-22441J-I



DEER HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

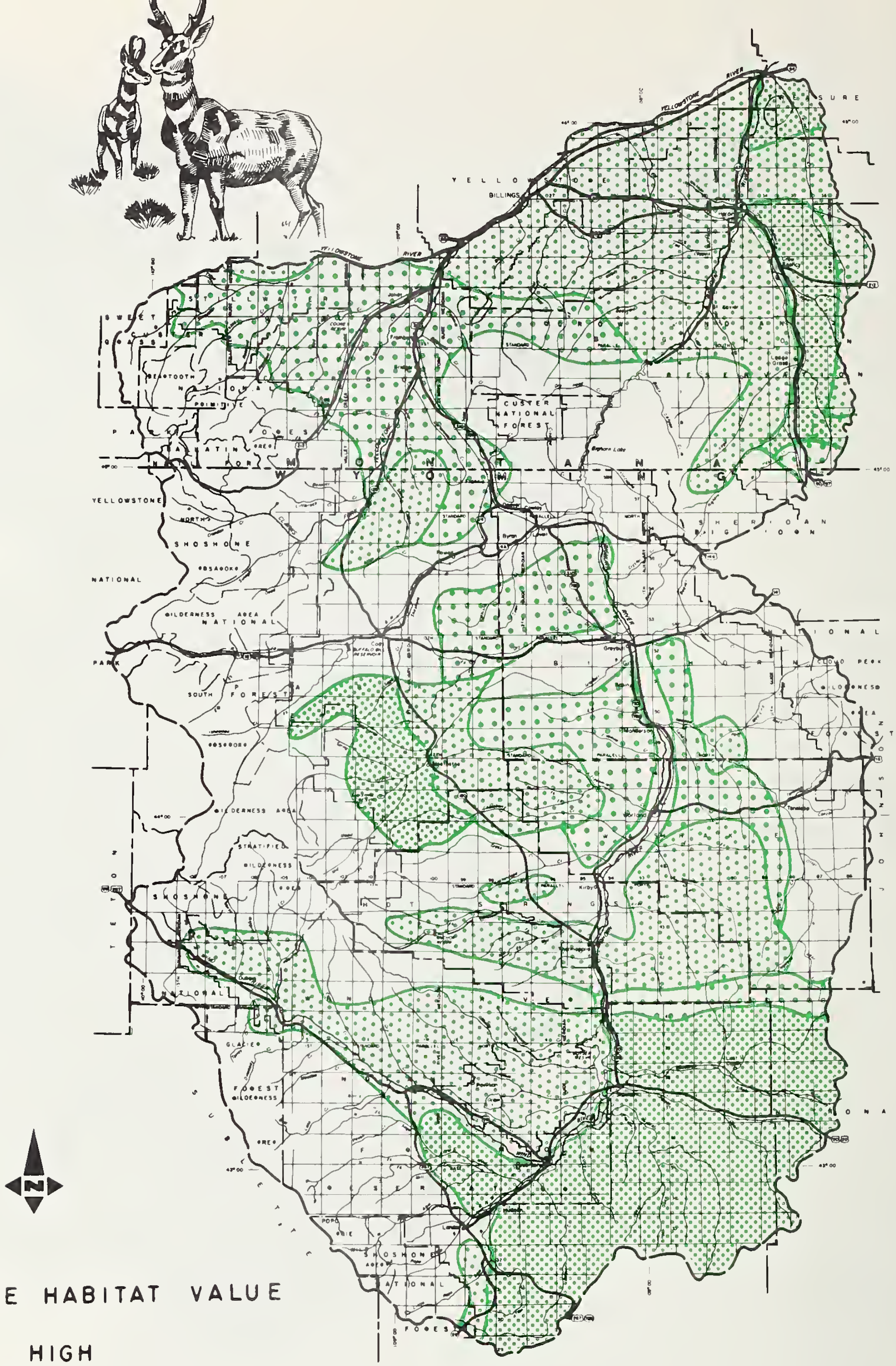
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study



ANTELOPE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA SCS-PORTLAND, OREG. 1978

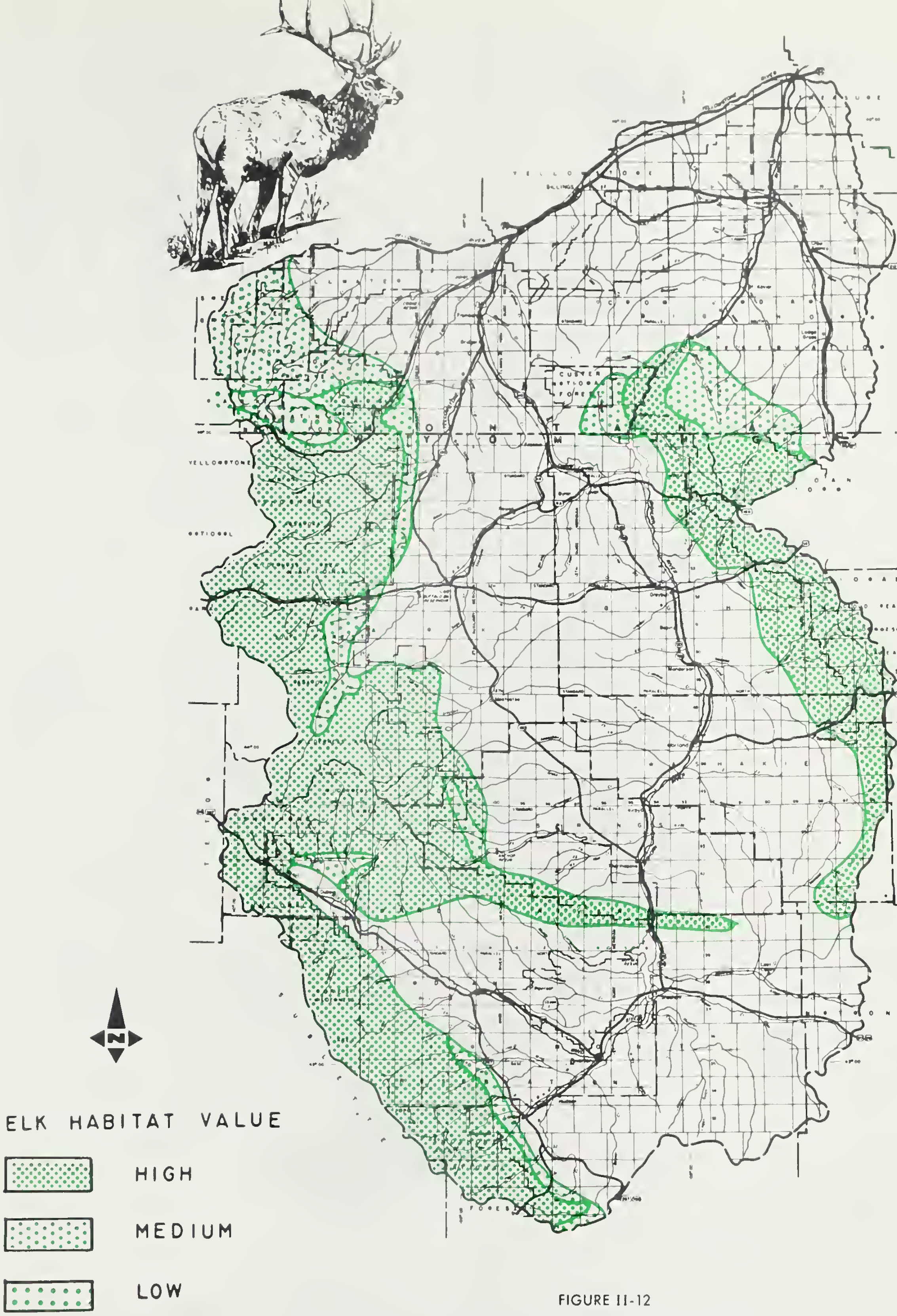


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

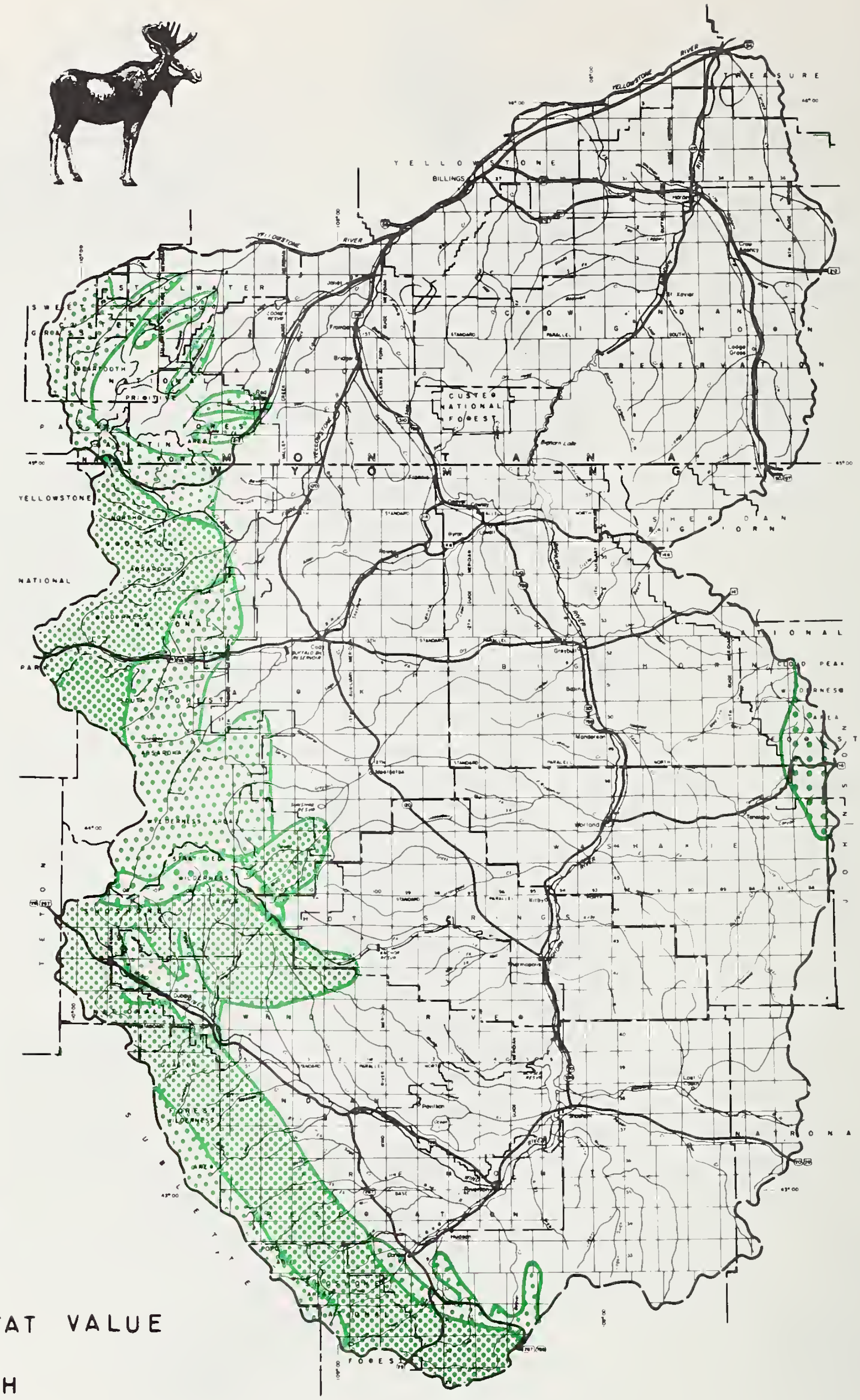
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA SCS-PORTLAND, OREG. 1975



MOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

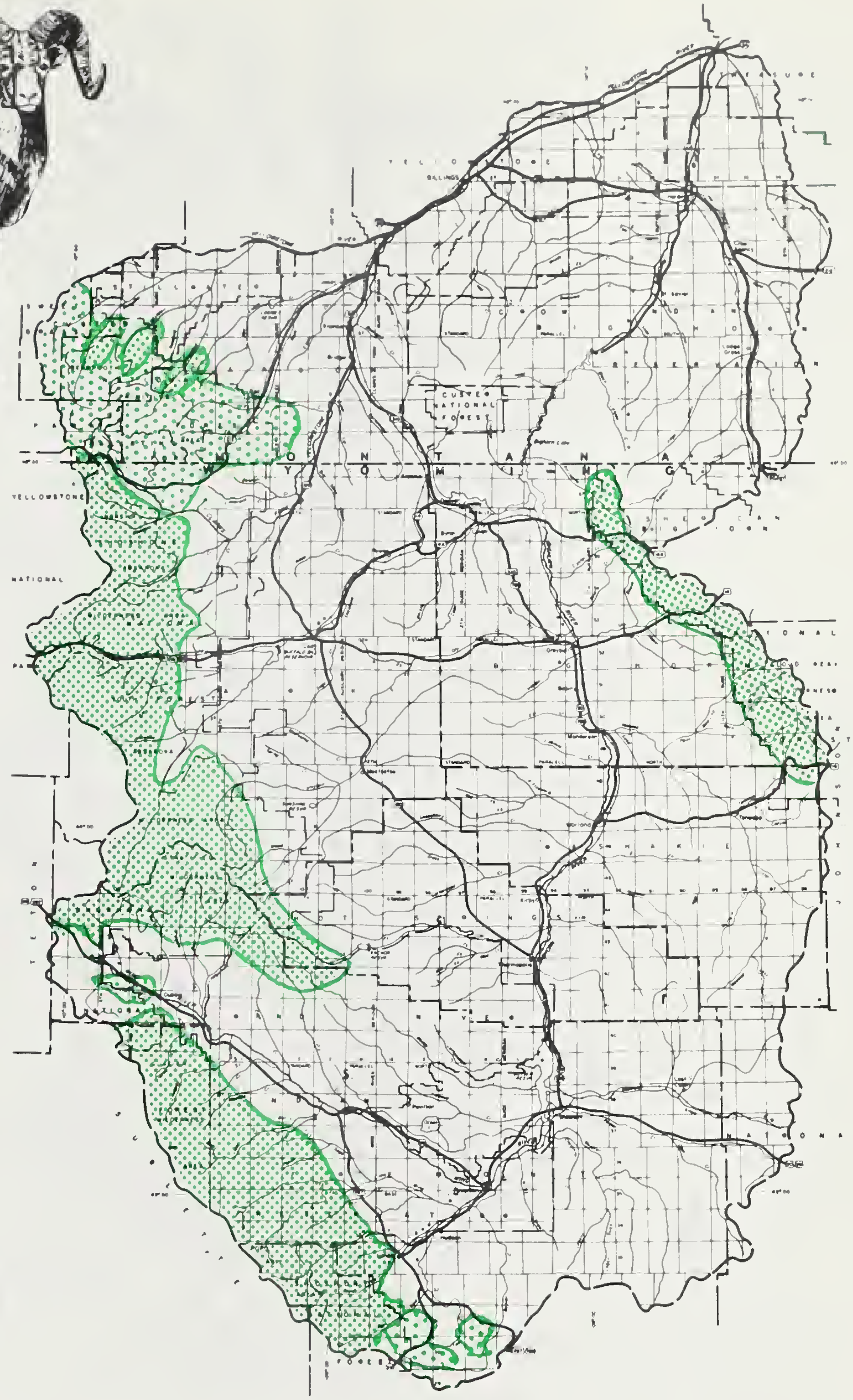
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG 1975



BIGHORN SHEEP
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

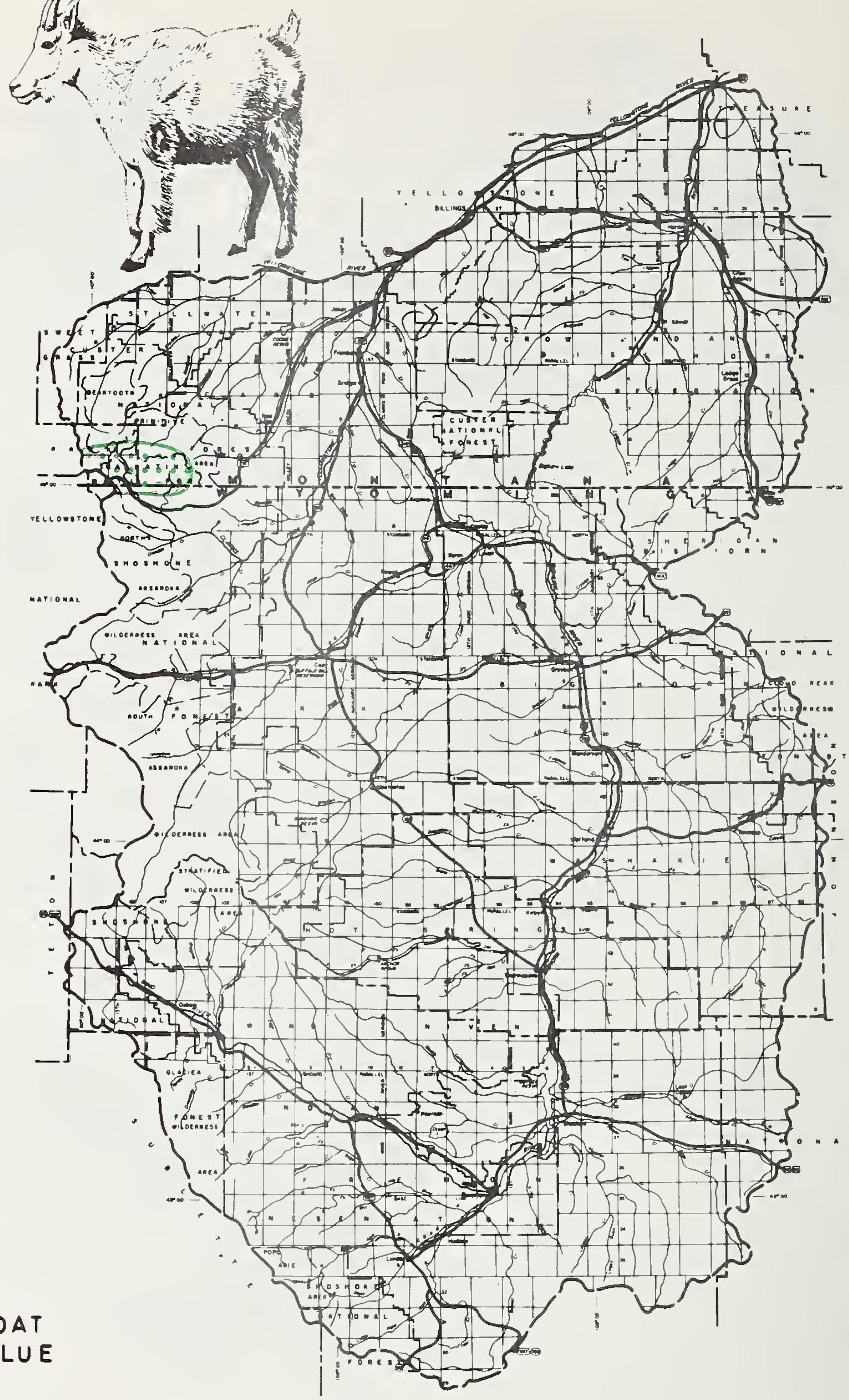
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS PORTLAND, OREG. 1975



MOUNTAIN GOAT
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975

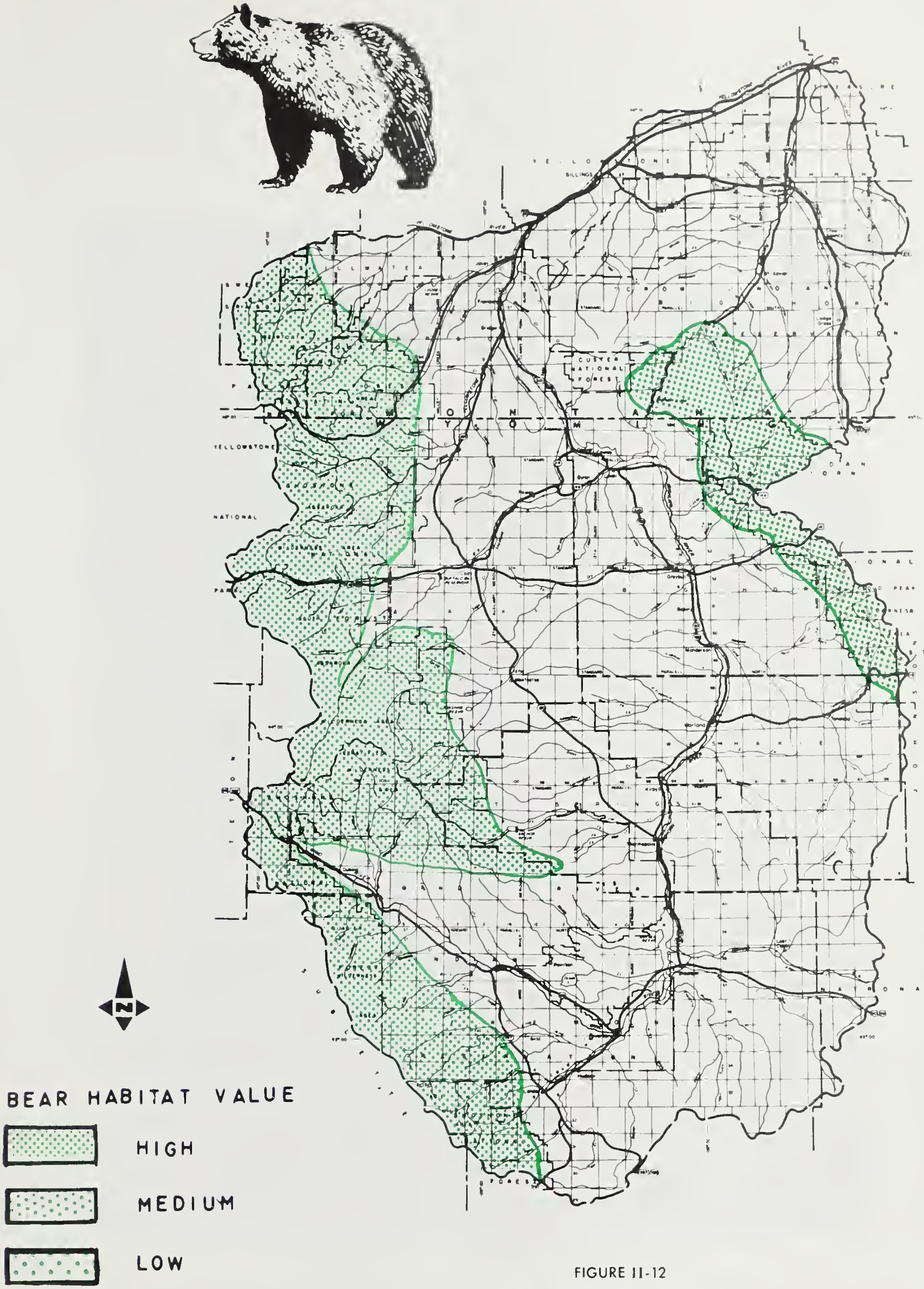


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

PLATE 5

Water resources of the basin depend on the melting of the high country snowpack. Much of the basin presently has abundant, good quality water. U.S. FOREST SERVICE PHOTO

In some locations, the Madison Flathead formations are capable of producing large flows. This is an artesian well with over 200 pounds per square inch of pressure.

This artesian well provides water for sprinkler irrigation.

PLATE 6

Table II-8--Big game species and their habitat[1/]

Common names	Area inhabited: Wyoming[2/]	Area inhabited: Montana	Total	Estimated population: Wyoming	Estimated population: Montana	Total
	---------1,000 acres-----			--------------numbers-------------		
Elk	4,389	1,087	5,476	18,000	600	18,600
Deer	8,764[3/]	4,989	18,168	57,900	22,000	79,900
Moose	1,811	416	2,227	700	400	1,100
Antelope	8,742	3,524	12,266	13,100	5,000	18,100
Bear	4,191	908	5,099	900	500	1,400
Bighorn sheep	2,290	620	2,910	1,800	500	2,300
Mountain goat	100	96	196	NA[4/]	400	NA[4/]

1/ From data from state Game and Fish Commissions.
2/ Data do not include Indian trust lands or national park lands in Wyoming.
3/ Figure II-12 shows the entire basin (13,179,000 acres in Wyoming) as deer habitat. Indian trust lands, national park lands, alpine areas, badlands, towns, etc., are excluded from the 8,764,000 acres listed here.
4/ Data not available.

Upland and small game habitat

Various species of upland game can be found almost throughout the basin. Table II-9 lists species of upland game and their estimated area of habitat. Figure II-13 includes maps showing the location and general quality of habitat for pheasant, sage grouse, sharp-tailed grouse, mountain (blue and ruffed) grouse, hungarian partridge, merriam's turkey, and chukar partridge. Within these mapped areas is a wide range of quality habitat for each species. Short distance access to water and associated vegetation are general requirements for upland game. Private range and croplands provide important habitat areas for upland game.

Table II-9 --Habitat areas of upland game species

Common species name	Area inhabited: Wyoming	Area inhabited: Montana
	-----------1,000 acres-------	
Sage grouse	7,425	4,223
Sharp-tailed grouse	0	4,223
Blue and ruffed grouse	3,706	767
White-tailed ptarmigan	0	767
Ring-necked pheasant	803	7
Hungarian partridge (or gray partridge)	4,375	3,742
Chukar partridge	4,813	10
Bobwhite quail	5	0
Merriam's turkey	-	8
Cottontail rabbit	8,100	15

Waterfowl and wetland wildlife habitat

Waterfowl species found in the basin include canada geese, snow geese, mallards, and other ducks. Habitat for waterfowl and wetland wildlife ranges from the margins of high mountain lakes with restricted summer use to lands with impaired drainage in the lower portions of the basin. Irrigated croplands where grain crops are produced near small bodies of open water are particularly important to waterfowl. Figure II-14 shows major habitat areas and quality of habitat for ducks and geese. Stock ponds on rangelands are also very important waterfowl habitat.

There are no national wildlife management areas (refuges) in the basin. The Wyoming Game and Fish Commission owns 2,280 acres and administers 10,540 acres of federal lands near Riverton for wildlife. About 6,300 acres of this area is the surface of Ocean Lake. The Commission is also cooperating with agencies of the Department of Interior in developing a waterfowl management facility near Yellowtail Reservoir. About 1,000 acres of this area will have developed marshes with water control facilities.

Nongame birds

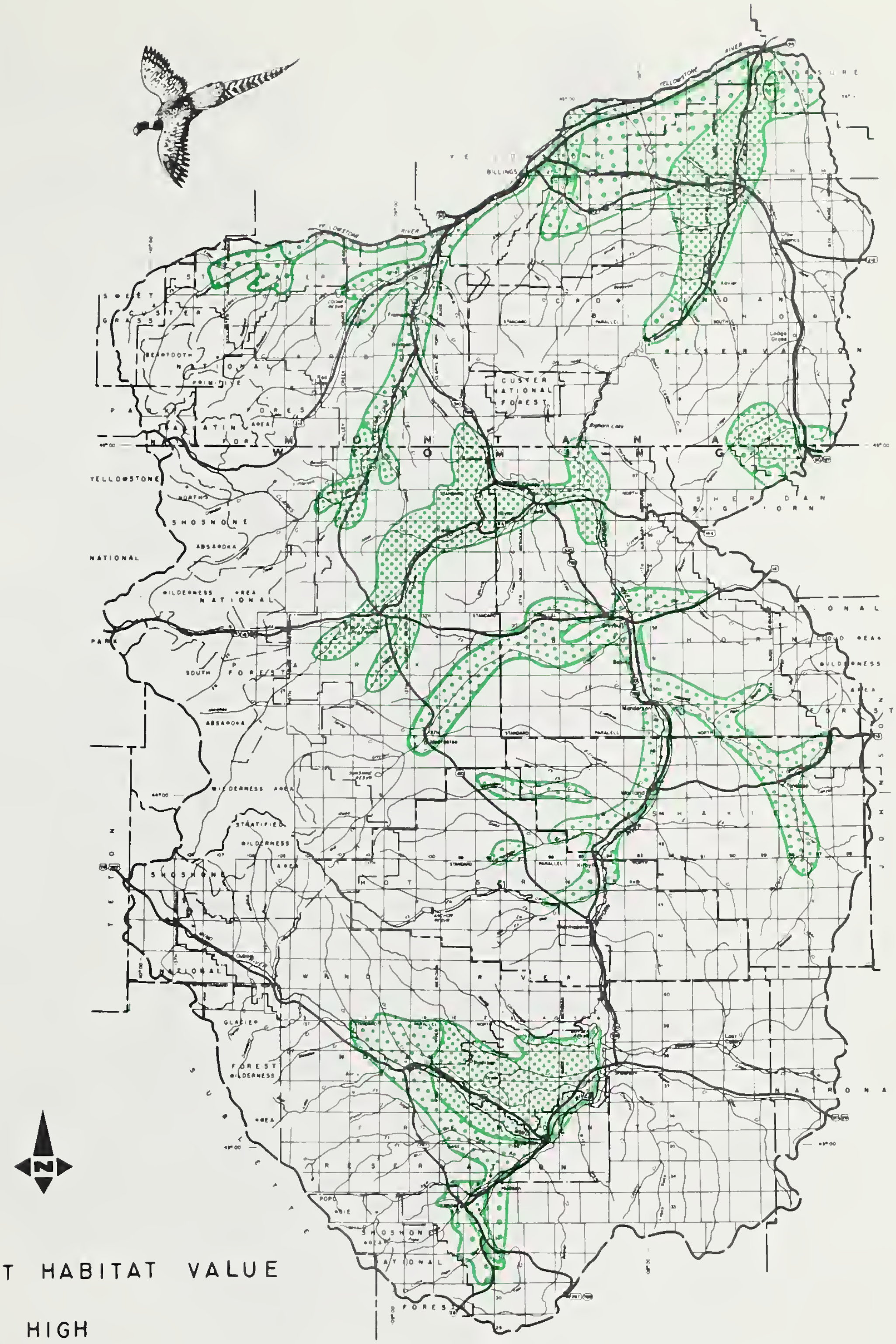
Many nongame species exist throughout the basin. Most of these birds are protected by federal or state law. Table II-10 is a list of commonly observed species in the basin as prepared by Dr. Oliver Scott in affiliation with the Murie Audubon Society, Casper, Wyoming.

Nongame mammals

Beaver, mink, muskrat, otter, marten, red fox, skunk, weasel, raccoon, jackrabbit, badger, coyote, bobcat, lynx, and limited numbers of fisher and wolverine are found in portions of the basin. The coyote has been subject to almost continuous control programs. The jackrabbit is hunted as a night sport when populations are high. Trapping is a minor industry in the basin. Landowners who incur damage, some hobby trappers, and a very few professional trappers do some trapping. Bobcats are hunted with dogs for sport or in predator control activities. On the southern flank of the Pryor Mountains is a wild horse range. This reserve is important, as it is one of the few formally recognized wild horse ranges in the country.

Fisheries

The streams in the basin have been mapped as shown in figure II-15 into five classifications based upon aesthetics, availability, and productivity. As shown on the map, class I represents fisheries of national importance. Class II includes fisheries of statewide importance, class III of regional importance, class IV of local importance, and class V streams are often incapable of supporting a fishery. Table II-11 lists miles of stream fishery by class.



PHEASANT HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

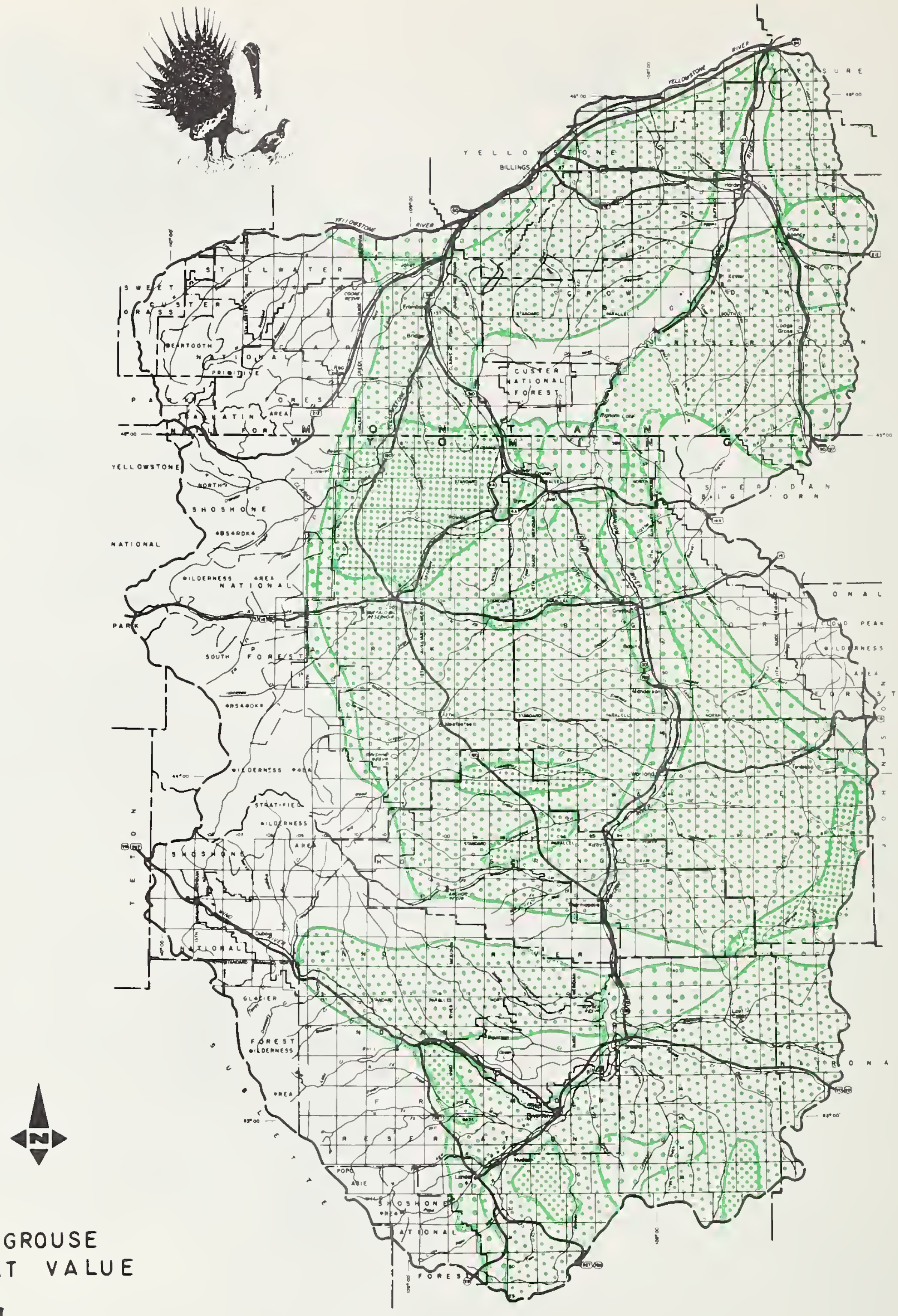
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND OREG 1975



SAGE GROUSE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS-PORTLAND OREG. 1975

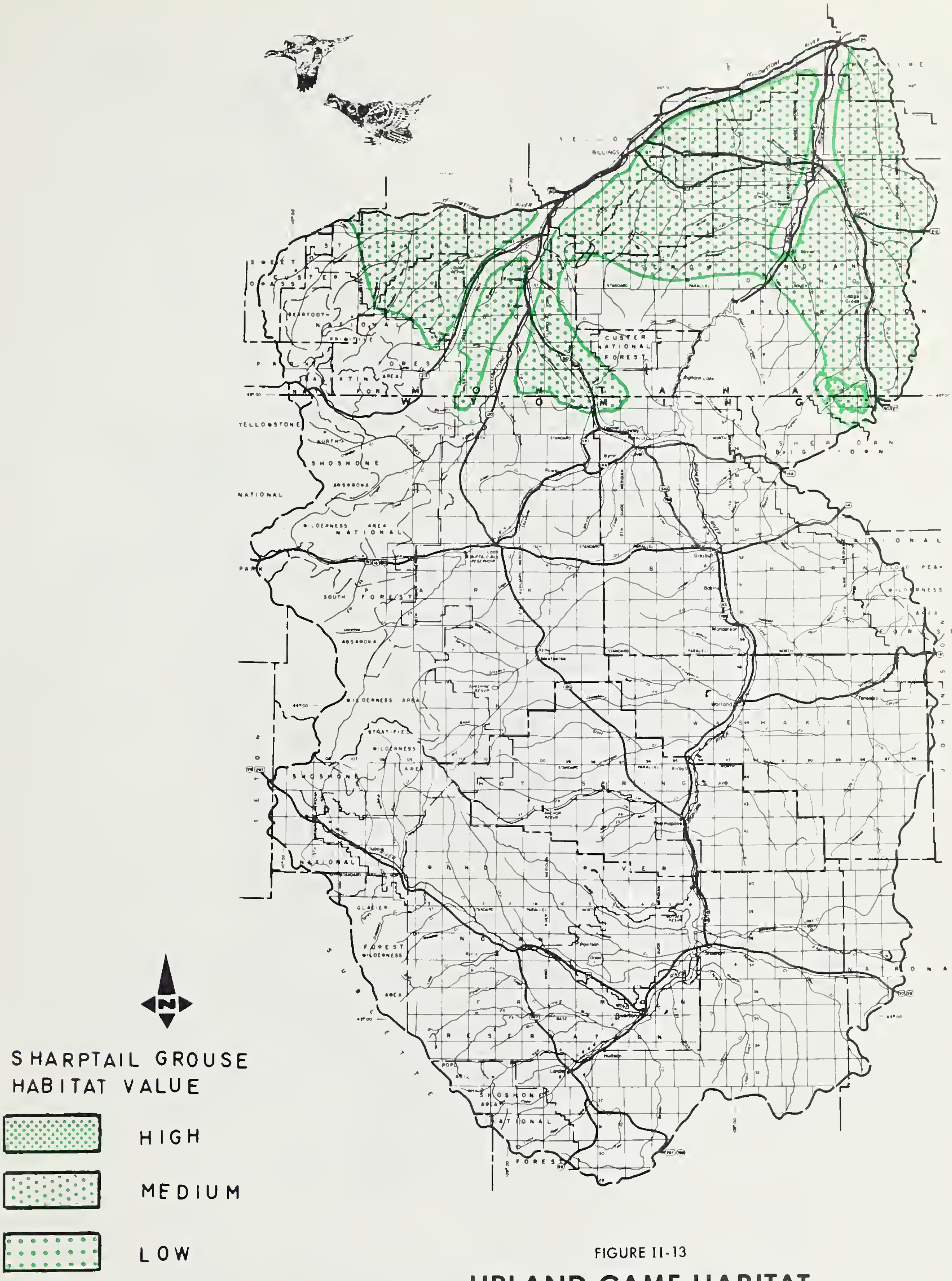


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

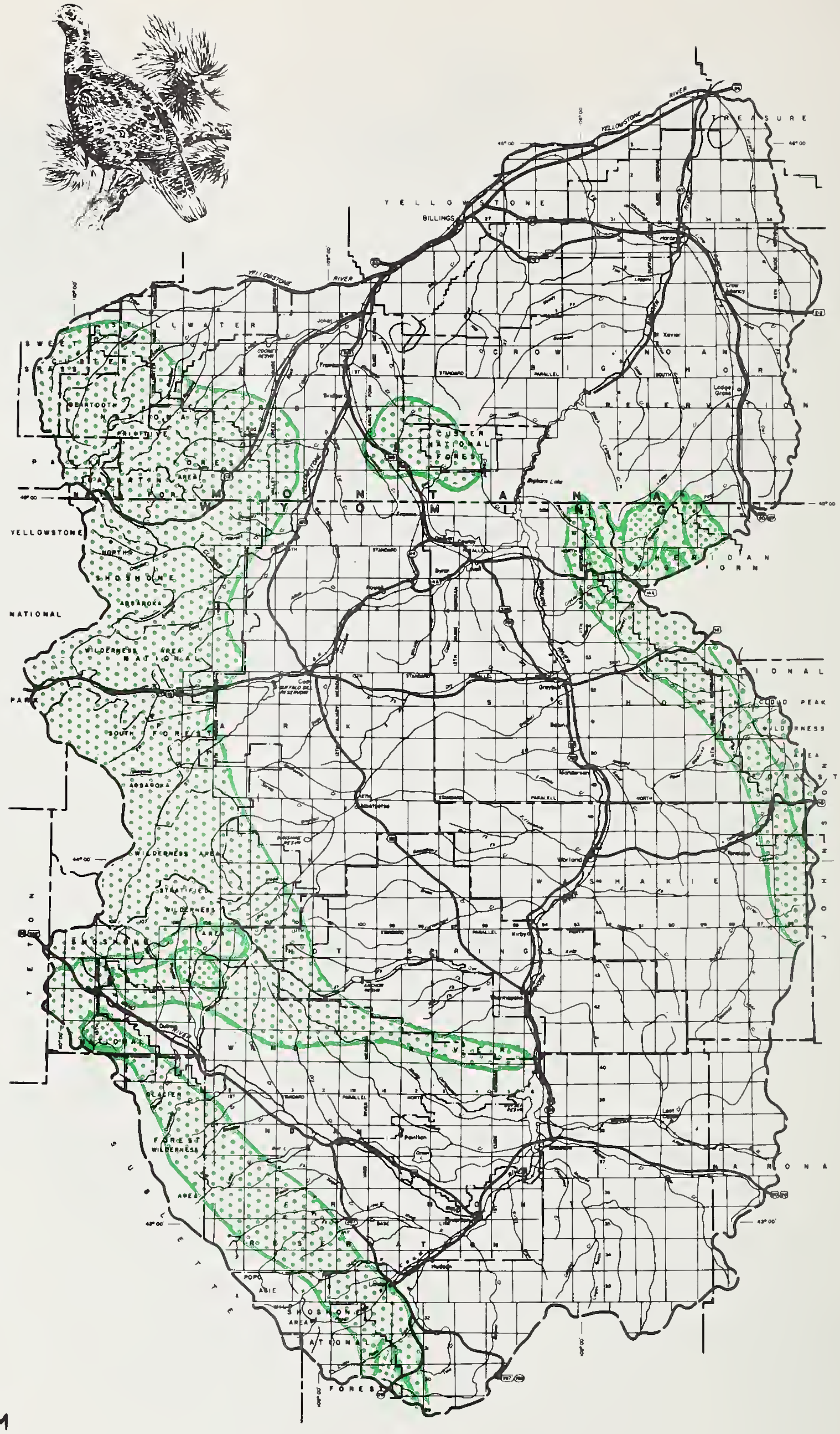
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



MOUNTAIN GROUSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

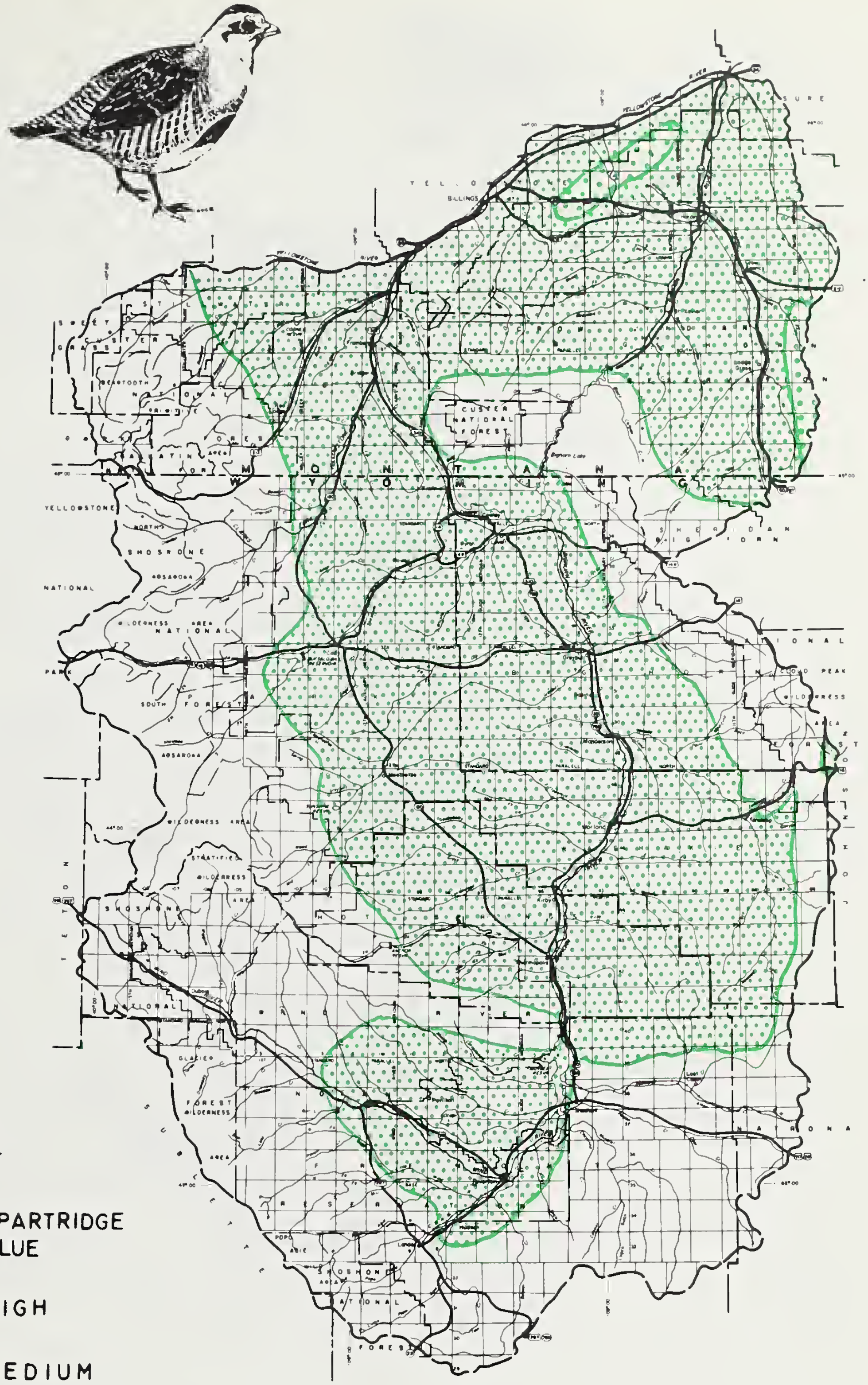
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



HUNGARIAN PARTRIDGE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

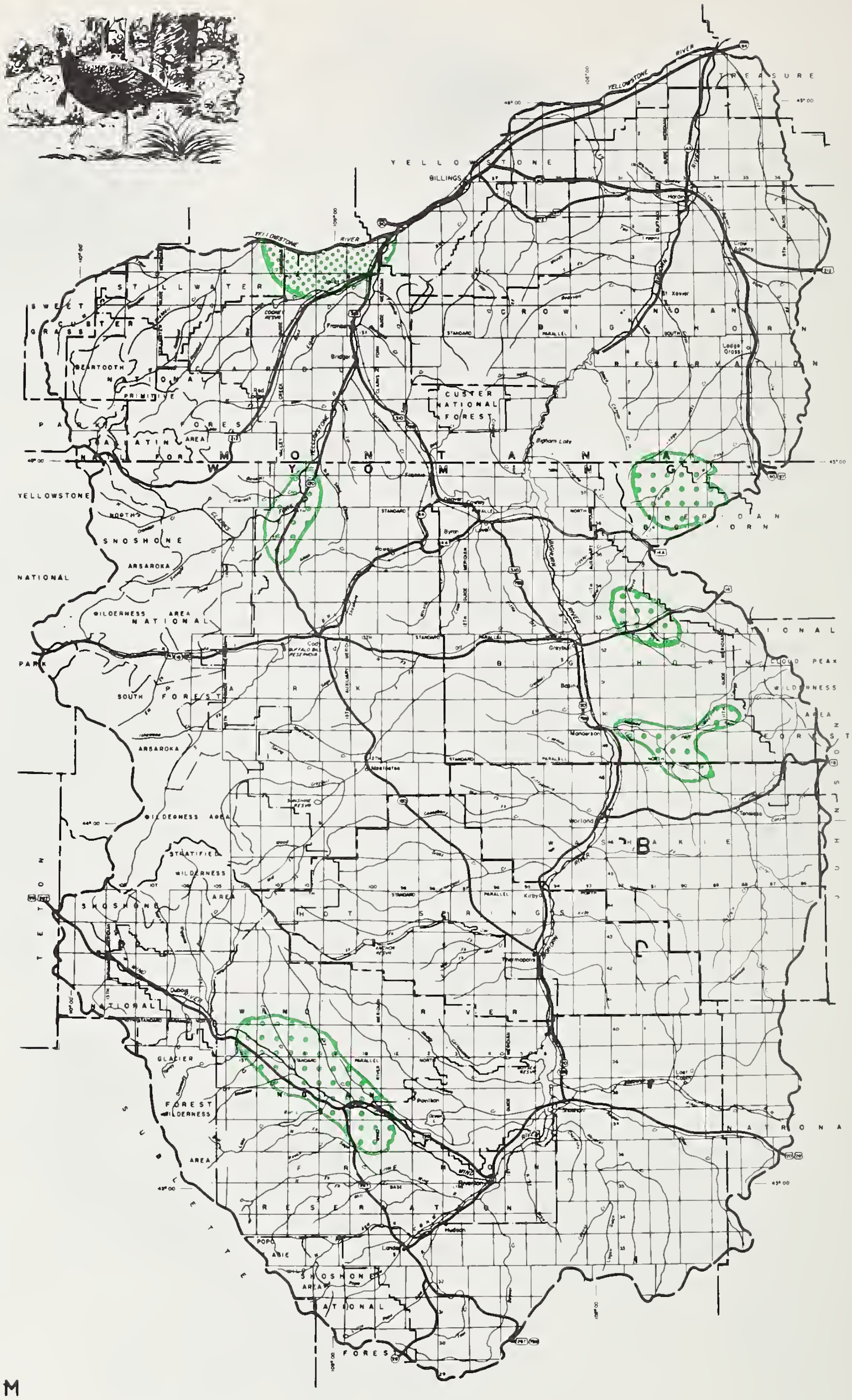
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



TURKEY
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

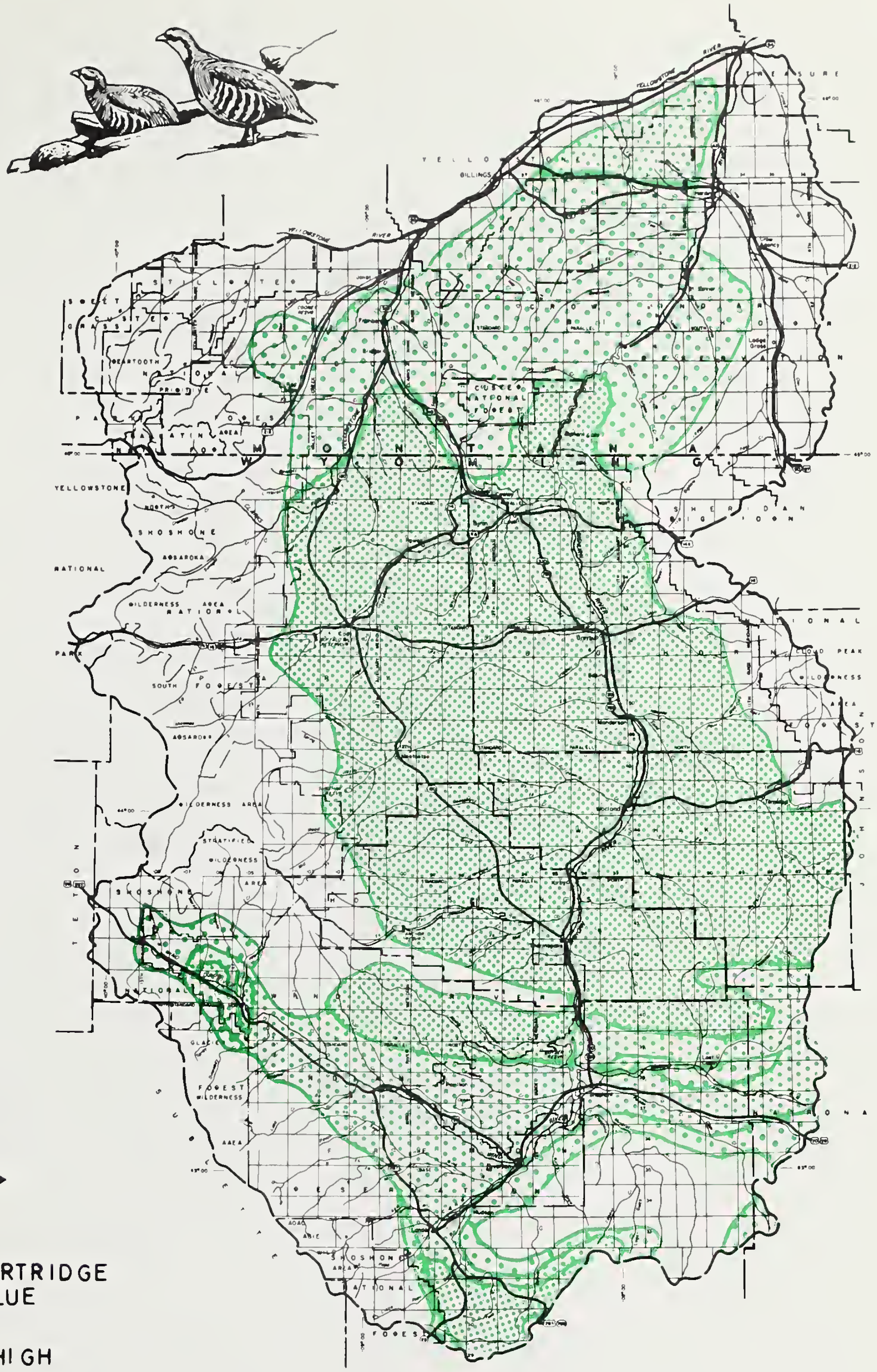
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



CHUKAR PARTRIDGE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG 1975

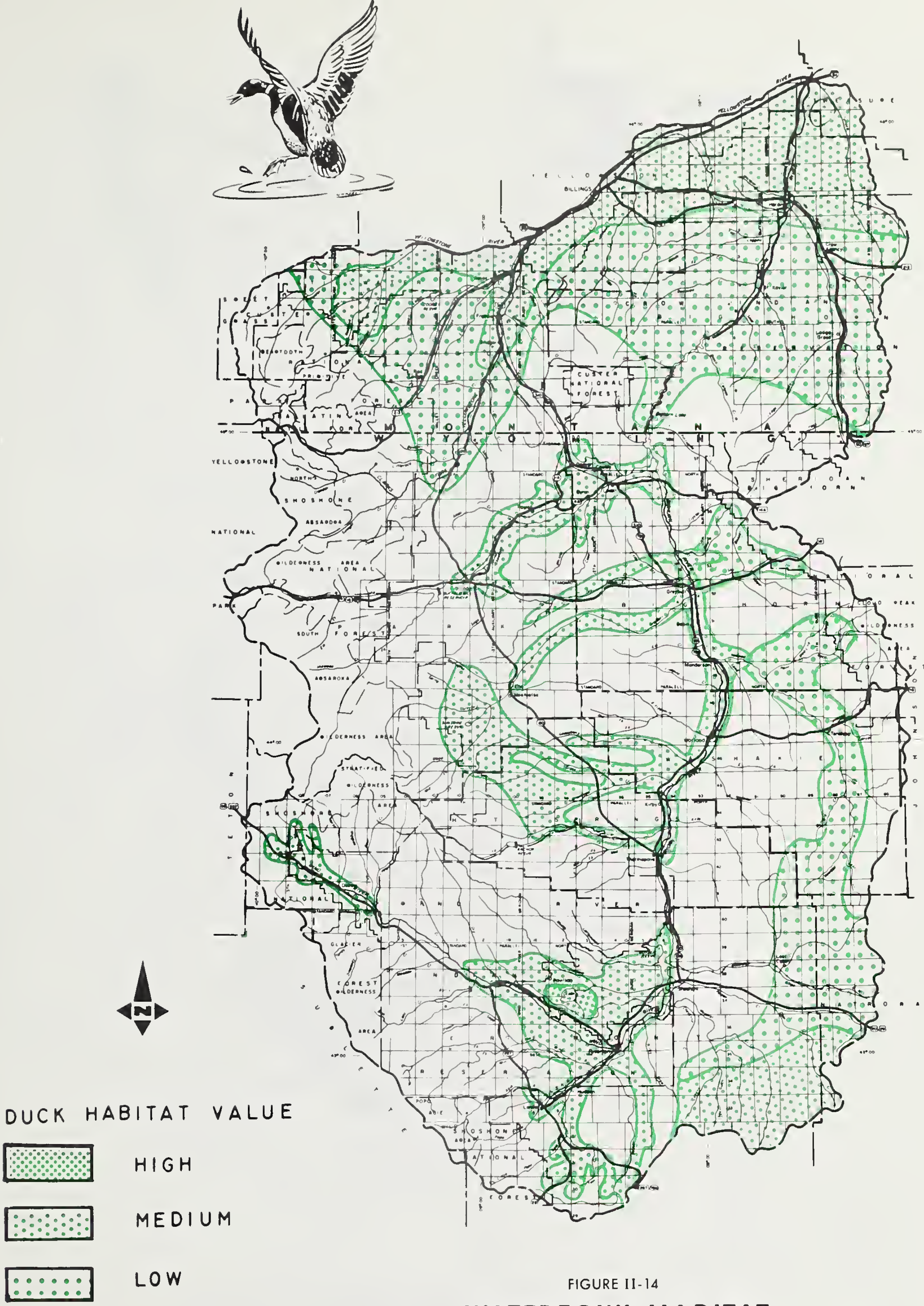


FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

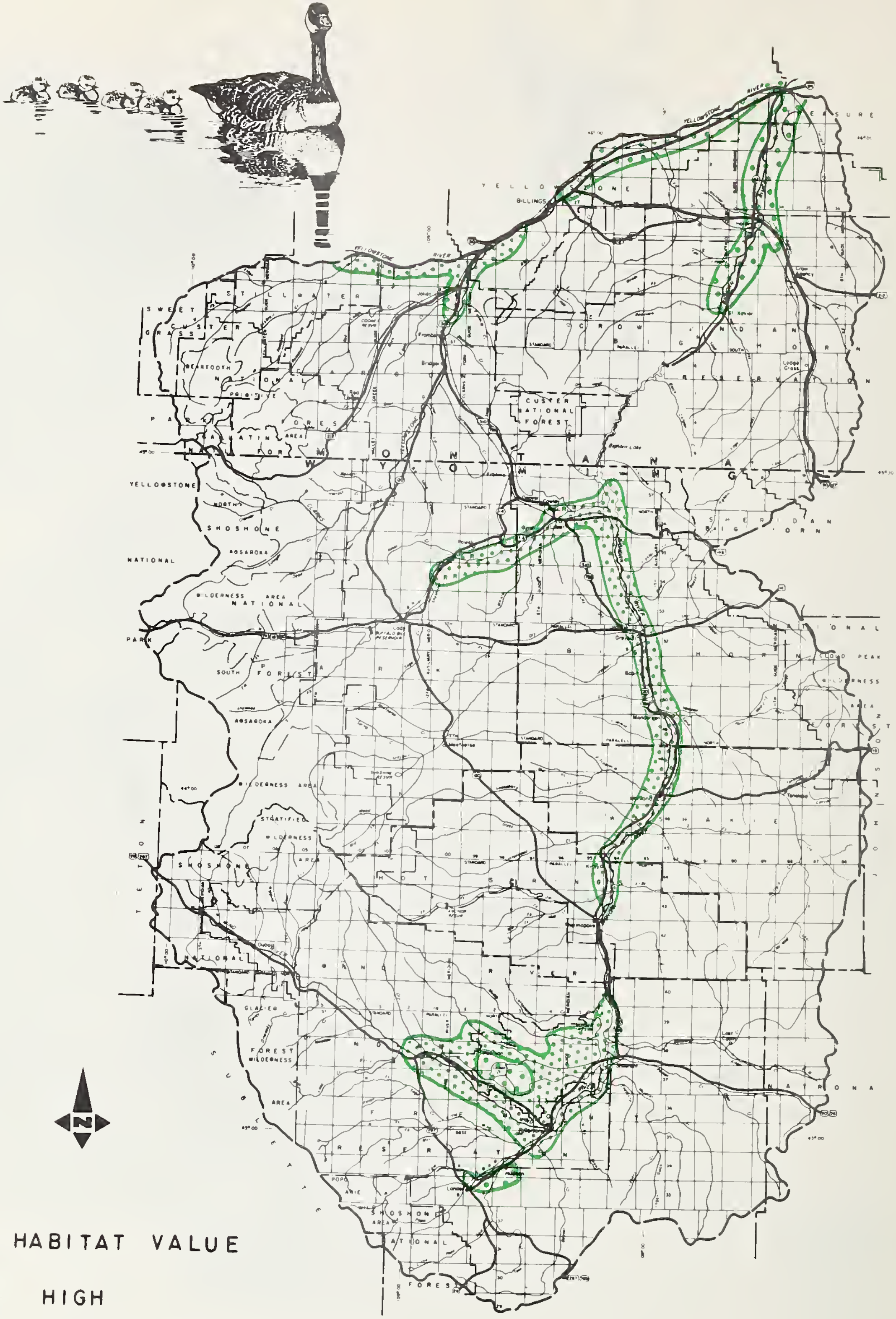
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG 1975



GOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

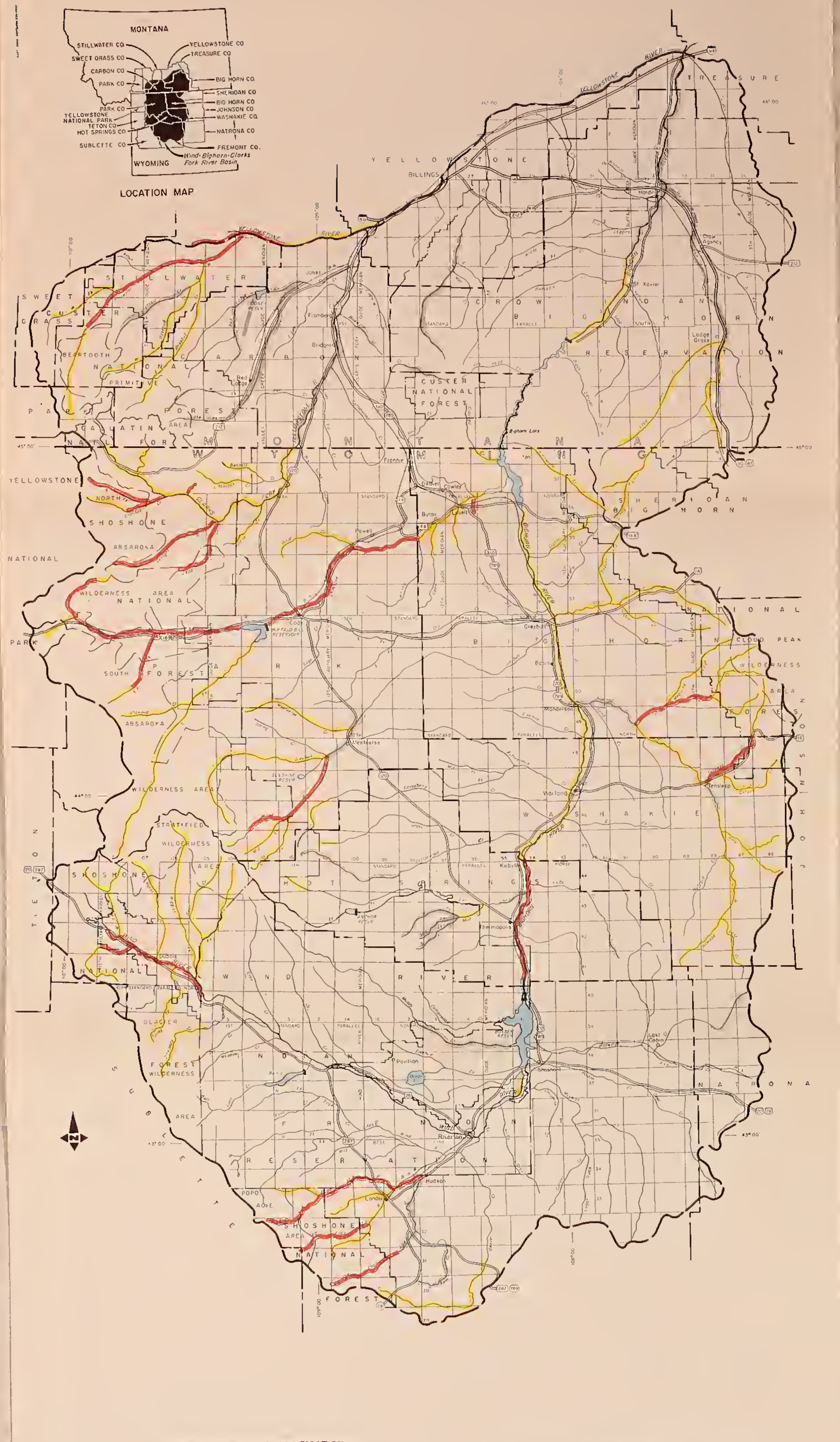
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG 1975



STREAM FISHERY CLASSIFICATION

Premium trout waters – fisheries of national importance

Very good trout waters – fisheries of statewide importance

Important trout waters – fisheries of regional importance

Low production waters – fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure

FIGURE II-15

STREAM FISHERY CLASSIFICATION

WIND · BIGHORN · CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22441K

Table II-10--Birds seen in the Wind-Bighorn-Clarks Fork River Basin

Name of Species	Code	Name of Species	Code	Name of Species	Code
Common Loon	(3m s)	Turkey Vulture	(2s)	Greater Yellowlegs	(3m)
Horned Grebe	(2m)	Goshawk	(3r)	Lesser Yellowlegs	(2m)
Eared Grebe	(2s)	Sharp-shinned Hawk	(3r)	Knot	(5m)
Western Grebe	(2s)	Cooper's Hawk	(3s)	Pectoral Sandpiper	(3m)
Pied-billed Grebe	(2s)	Red-tailed Hawk	(2r)	White-rumped Sandpiper	(4m)
White Pelican	(2m s)	Broad-winged Hawk	(5m)	Baird's Sandpiper	(2m)
Double-crested Cormorant	(2m s)	Swainson's Hawk	(2s)	Least Sandpiper	(2m)
Great Blue Heron	(2s)	Rough-legged Hawk	(2wv)	Ounlin	(4m)
Green Heron	(4m)	Ferruginous Hawk	(2s)	Long-billed Oowitcher	(2m)
Snowy Egret	(3m s)	Golden Eagle	(2r)	Stilt Sandpiper	(3m)
Black-crowned Night Heron	(2m s)	Bald Eagle	(2wv s)	Semipalmated Sandpiper	(3m)
American Bittern	(3s)	Marsh Hawk	(2r)	Western Sandpiper	(3m)
White-faced Ibis	(3m)	Osprey	(3m s)	Marbled Godwit	(3m)
Whistling Swan	(4m)	Prairie Falcon	(3r)	Hudsonian Godwit	(5m)
Canada Goose	(2r)	Peregrine Falcon	(4r)	Sanderling	(3m)
Snow Goose	(4m)	Pigeon Hawk	(4r)	Avocet	(2s)
Mallard	(2r)	Sparrow Hawk	(2s)	Black-necked Stilt	(4s)
Gadwall	(2s)	Sage Grouse	(2r)	Wilson's Phalarope	(1s)
Pintail	(2s)	Ring-necked Pheasant	(2r)	Northern Phalarope	(2m)
Green-winged Teal	(2s)	Chukar	(2r)	Herring Gull	(4m)
Blue-winged Teal	(2s)	Gray Partridge	(r)	California Gull	(2s)
Cinnamon Teal	(2s)	Sandhill Crane	(2s)	Ring-billed Gull	(2m)
American Widgeon	(2s)	Virginia Rail	(3s)	Franklin's Gull	(2m)
Shoveler	(2s)	Sora	(2s)	Bonaparte's Gull	(3m)
Redhead	(2s)	American Coot	(1s)	Sabine's Gull	(4m)
Ring-necked Duck	(3m)	Semipalmated Plover	(3m)	Forster's Tern	(2m)
Canvasback	(2m s)	Piping Plover	(4m)	Common Tern	(4m)
Greater Scaup Ouck	(4m)	Snowy Plover	(5m)	Caspian Tern	(3s)
Lesser Scaup Duck	(2s)	Killdeer	(1s)	Black Tern	(2s)
Common Goldeneye	(2wv)	Mountain Plover	(3s)	Mourning Oove	(1s)
Barrow's Goldeneye	(2m s)	American Golden Plover	(5m)	Black-billed Cuckoo	(2s)
Bufflehead	(2m s)	Black-bellied Plover	(3m)	Screech Owl	(4s)
Oldsquaw	(5m)	Ruddy Turnstone	(4m)	Horned Owl	(2r)
Harlequin Duck	(3s)	Common Snipe	(2r)	Snowy Owl	(4wv)
White-winged Scoter	(4m)	Long-billed Curlew	(2s)	Burrowing Owl	(3s)
Surf Scoter	(4m)	Whimbrel	(3m)	Long-eared Owl	(3r)
Ruddy Duck	(2s)	Upland Plover	(2s)	Short-eared Owl	(2r)
Hooded Merganser	(3m)	Spotted Sandpiper	(2s)	Saw-whet Owl	(4m)
Common Merganser	(2r)	Solitary Sandpiper	(2m)	Poor-will	(2s)
Red-breasted Merganser	(3m)	Willet	(2s)	Common Nighthawk	(2s)
White-throated Swift	(2s)	House Wren	(2s)	Red-winged Blackbird	(1s)
Broad-tailed Hummingbird	(2s)	Winter Wren	(4m)	Bullock's Oriole	(2s)
Rufous Hummingbird	(3m)	Long-billed Marsh Wren	(2s)	Rusty Blackbird	(4m)
Calliope Hummingbird	(2s)	Rock Wren	(1s)	Brewer's Blackbird	(2s)
Belted Kingfisher	(2r)	Mockingbird	(3r)	Common Grackle	(2s)
Yellow-shafted Flicker	(3r)	Catbird	(2s)	Brown-headed Cowbird	(2s)
Red-shafted Flicker	(2r)	Brown Thrasher	(2s)	Western Tanager	(2s)
Red-headed Woodpecker	(3s)	Sage Thrasher	(2s)	Black-headed Grosbeak	(2s)
Lewis' Woodpecker	(2s)	Robin	(1r)	Blue Grosbeak	(4s)
Yellow-bellied Sapsucker	(2s)	Hermit Thrush	(3s Mts)	Indigo Bunting	(4s)
Hairy Woodpecker	(2r)	Swainson's Thrush	(2s Mts)	Lazuli Bunting	(2s)
Downy Woodpecker	(2r)	Veery	(2s)	Evening Grosbeak	(2wv)
Eastern Kingbird	(2s)	Mountain Bluebird	(2s)	Caccin's Finch	(2r)
Western Kingbird	(2s)	Townsend's Solitaire	(2r Mts)	House Finch	(2r)
Say's Phoebe	(2s)	Golden-crowned Kinglet	(2s Mts)	Pine Grosbeak	(3r Mts)
		Ruby-crowned Kinglet	(2s Mts)		
Traill's Flycatcher	(2s Mts)	Water Pipit	(2s A)	Gray-crowned Rosy Finch	(2wv 2s)
Least Flycatcher	(2s)	Bohemian Waxwing	(2wv)	Black Rosy Finch	(2s Mts)
Ousky Flycatcher	(2s)	Cedar Waxwing	(2s)	Common Redpoll	(2wv)
Western Flycatcher	(2s)	Northern Shrike	(2wv)	Pine Siskin	(2s)
Western Wood Pewee	(1s)	Loggerhead Shrike	(2s)	American Goldfinch	(2s)
Olive-sided Flycatcher	(3s Mts)	Starling	(2r)	Red Crossbill	(2r Mts)
Horned Lark	(1r)	Solitary Vireo	(3s)	White-winged Crossbill	(4m)
Violet-green Swallow	(2s)	Red-eyed Vireo	(2s)	Green-tailed Towhee	(2s Mts)
Tree Swallow	(2s)	Warbling Vireo	(1s)	Rufous-sided Towhee	(2s)
Bank Swallow	(3s)	Tennessee Warbler	(4m)	Lark Bunting	(1s)
Rough-winged Swallow	(2s)	Orange-crowned Warbler	(2s)	Savannah Sparrow	(2s)
				Grasshopper Sparrow	(2s)
Barn Swallow	(3s)	Nashville Warbler	(4m)	Vesper Sparrow	(1s)
Cliff Swallow	(1s)	Yellow Warbler	(1s)	Lark Sparrow	(2s)
Purple Martin	(4s)	Myrtle Warbler	(2m)	Slate-colored Junco	(3wv)
Gray Jay	(2r Mts)	Audubon's Warbler	(2s)	Oregon Junco	(2r)
Steller's Jay	(2r Mts)	Black-throated Gray Warbler	(2s)	Gray-headed Junco	(2s Mts)
Black-billed Magpie	(1r)	Townsend's Warbler	(3m)	Tree Sparrow	(2wv)
Common Raven	(2r Mts)	Blackpoll Warbler	(4m)	Chipping Sparrow	(2s Mts)
Common Crow	(2r)	Northern Waterthrush	(3m)	Brewer's Sparrow	(2s)
Pinon Jay	(2r)	MacGillivray's Warbler	(2s Mts)	Harris' Sparrow	(3wv)
Clark's Nutcracker	(2r Mts)	Yellowthroat	(2s)	White-crowned Sparrow	(2s Mts)
Black-capped Chickadee	(2r)	Yellow-breasted Chat	(2s)	White-throated Sparrow	(3m)
Mountain Chickadee	(2r)	Wilson's Warbler	(2s Mts)	Fox Sparrow	(2s 3wv)
White-breasted Nuthatch	(2r)	American Redstart	(3s)	Lincoln's Sparrow	(2s Mts)
Red-breasted Nuthatch	(2r)	House Sparrow	(1r)	Song Sparrow	(2r)
Pygmy Nuthatch	(3ri)	Bobolink	(3s)	McCown's Longspur	(2s)
Brown Creeper	(2r)	Western Meadowlark	(1s)	Lapland Longspur	(3m)
Water Ouzel	(2s Mts)	Yellow-headed Blackbird	(2s)	Snow Bunting	(3wv)

KEY TO CODE

1 - abundant	m - migrant	Mts - mountains
2 - common	s - summer resident	A - alpine zone
3 - uncommon	r - resident	
4 - rare	wv - winter visitant	
5 - casual	f - formerly	
	i - irregular	

Lakes, reservoirs, and ponds were not classified as were the streams, but are listed by seven types in table II-12. Low elevation, man-made lakes and reservoirs are very important fisheries if judged by fisherman use. They support most of the fishing pressure in the basin. Lakes, ponds, and reservoirs provide nearly four times as many fisherman-days as do the streams.

Table II-11--Summary of stream miles by fishery class

State	I	II	III	IV	V	Total classified
	miles					
Wyoming	3	449	2,435	1,286	81	4,254
Montana	0	179	48	269	0	496
Total	3	628	2,483	1,555	81	4,750

Table II-12--Number of lakes, ponds, and reservoirs with fish

State	Natural alpine lakes	Alpine reservoirs	Lowland lakes	Lowland reservoirs	Farm ponds: Cold water species	Farm ponds: Mixed species	Farm ponds: Warm water species	Total
	number							
Wyoming	741	25	30	75	126	5	42	1,044
Montana	122	2	6	3	81	0	3	217
Total	863	27	36	78	207	5	45	1,261

The most common trout include rainbow, brown, brook, golden, and cutthroat. Brook trout and native cutthroat trout are more common in the high mountain lakes and streams. Other important game fish include ling, grayling, walleye pike, bass, and crappie. Nongame species such as carp are being studied for commercial fish production in Ocean Lake. Several other nongame species are found in the basin.

Threatened species

Mammal and bird species which may be found in the basin that are classed as threatened, or for which status is undetermined, are listed below:

Bighorn sheep are native to the Bighorn Basin.

U.S. FOREST SERVICE PHOTO

Big game are plentiful in the basin.

There is a wide variety of game birds in the basin.

Grizzly Peak ski area provides about 65,000 skier days per year to people of all ages and skills. USDA-FOREST SERVICE PHOTOS

PLATE 8

Status	Class	Species
Threatened	Mammal	Spotted bat Grizzly bear Black-footed ferret
	Bird	Prairie falcon American peregrine falcon
Status Undetermined	Mammal	Pine marten Fisher Wolverine Canada lynx
	Bird	Ferruginous hawk American osprey

Compiled from:
Threatened Wildlife of the United States, USDI, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, 1973

RECREATIONAL FEATURES

Outstanding natural and scenic resources offer great opportunities for outdoor recreation in the basin. The mountains are the principal area of recreational activity because of their scenery, forests, lakes, streams, wildlife, and cool summer climate. The mountains contain several wilderness and primitive areas and a small part of Yellowstone National Park. Scattered glacial lakes and mountain streams provide spectacular scenery and cold water fishing. Numerous forest campsites are provided in the national forests.

In the lower areas of the basin are scenic desert formations, larger rivers, lakes, and reservoirs. Irrigated croplands add greenery to the desert landscape. Recreational facilities are also provided by the private sector. Dude ranches, lodges, ski resorts, outfitting, packing, hunting trips, fishing trips, summer cottages, campgrounds, and other services are available.

Public access is provided at the larger reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake. These lakes are popular recreation areas. Bighorn Lake is particularly scenic. Major highways and other roads provide access to some of the mountain areas. Public fishing and hunting access areas are available at several locations along important fishing streams. State parks at Boysen, Buffalo Bill, and Thermopolis Hot Springs provide picnic, camping, or swimming facilities. The Buffalo Bill Museum at Cody is one of the most popular recreational facilities in the basin. Archeological sites such as the Medicine Wheel, east of Lovell in the Bighorn Mountains, also attract many visitors. The Custer Battlefield National Monument is an important historical site. The site of

Fort C. F. Smith and Chief Plenty Coups Memorial State Monument are other important historical sites. The Beartooth Highway, from Red Lodge to Yellowstone National Park, winds to elevations of 11,000 feet. The fact that alpine vegetation and spectacular scenery may be viewed from a passenger car (a relatively rare opportunity) is reason to consider designating this as a National Scenic Highway.

Part of the scenic desert badlands area north of Gooseberry Creek and west of Worland could be designated as a National Monument.

The Pryor Mountains provide a unique opportunity for the student of archeology, history, or wild horses. This area was inhabited as much as 9,000 years ago. Chief Joseph and his tribe traveled this way in 1877 when pursued by the U. S. Army. This area is being studied for its archeological value and need for preservation.

QUALITY OF THE NATURAL ENVIRONMENT

General

The low population density of less than three persons per square mile has tended to preserve much of the quality of the environment in a seminative state. However, the environment has been altered, to varying degrees, by activities of man. Past grazing by livestock and wildlife has been excessive for the resource in some areas and caused an increase in the amount of big sagebrush. It is generally considered that pure stands of big sagebrush do not provide quality watersheds. About three-fourths of a million acres of irrigated cropland have been developed along mountain streams and on desert benches. Inefficient irrigation practices which result in large amounts of waste water have caused erosion of small streams and waterways and deposited sediment into the larger rivers and man-made lakes.

These irrigation diversions also affect fish habitat by reducing natural streamflows. Conversely, irrigated lands have encouraged increased numbers of some species of wildlife and allowed introduction of some exotic species such as the pheasant.

Recreational use by hunters, fishermen, and tourists have affected environmental quality in more remote regions. Mining and oil field development have affected landscapes and streams.

Forests are very important components of the natural environment. Forested lands are quite stable and, unless disturbed, have low rates of erosion and sediment production.

Water quality

In the planning of the use of water resources, consideration must be given to water quality. Every water use has definite water quality requirements. Whenever water quality deteriorates below the minimum

Outfitting and packing are important activities.
USDA - FOREST SERVICE PHOTO

Fishing in a mountain lake can be a unique recreation experience. USDA - FOREST SERVICE PHOTO

The Buffalo Bill Museum at Cody is one of the most popular tourist stops in the basin.

From Rock Creek valley to the alpine tundra over the switchbacks of the Beartooth Highway USDA - FOREST SERVICE PHOTO

An alpine lake on the Beartooth plateau. USDA-FOREST SERVICE PHOTO

Big Bull Elk Canyon camp in Bighorn National Recreation area.

BUREAU OF RECLAMATION PHOTO

requirement of any use, the use is lost or made more expensive by the need for water treatment. The aim of water quality programs is to maintain or improve water quality so that multiple water uses can be maintained.

The quality of most of the waters of this river basin can be described as good. Excellent quality is found in the high mountains where most of the basin's water originates. Remoteness and lack of developed access have protected water quality in these mountainous forest watersheds. However, there is a gradual decline in quality as the water moves downstream. This decrease in quality is largely the result of natural conditions. Runoff from lower elevation lands carries much higher concentrations of minerals, sediments, and other pollutants than runoff from the mountain watersheds.

While there are places on the streams, notably near towns and a few feedlots where biologic pollutants are discharged into streams, we have no record of significant adverse effects at present. Dissolved oxygen levels are apparently satisfactory at all locations where sampling is conducted on a regular basis. The major pollutants of water in the basin are suspended sediments and dissolved solids. Table II-13 is a list of the average annual concentration of dissolved solids at locations where these data are measured and published by the U. S. Geological Survey.

The recommended maximum concentration of total dissolved solids in private or semipublic water supplies is 1,000 milligrams per liter (mg/l) when no other water is available, and for livestock up to 2,500 mg/l is acceptable.

Concentrations of dissolved solids (TDS) and suspended sediments vary greatly during the year. For example, in water year 1966, TDS in the Little Wind River near Riverton varied from 290 mg/l on May 15 to 842 on August 20 and 874 on March 18. The suspended sediment in Fivemile Creek near Shoshoni in the same year varied from 180 mg/l on November 7 to 3,900 mg/l on April 16. Badwater Creek at Lysite varied from 68 mg/l on January 7 to 38,000 mg/l on June 23. Suspended sediment loads are not widely measured in the basin and are not listed for that reason.

Reservoirs affect the concentration of TDS adversely. Evaporation from the reservoir causes increased concentrations. They generally have a significant beneficial effect in reducing concentrations of suspended sediments. This effect is important to the class I blue ribbon trout stream fishery 3 miles downstream from Boysen Reservoir, for example.

Irrigation return flows are important contributors of suspended sediment and TDS loads to the lower streams of the basin. Much of the increase of TDS in the Shoshone River from Lovell to Kane is the result of irrigation return flows.

Natural mineralized hot springs are also important contributors of dissolved solids. Much of the increase in TDS in the Bighorn River from Boysen to Lucerne comes from Thermopolis Hot Springs. These are claimed

Table II-13—Average annual concentration of total dissolved solids

Gaging location	Total dissolved solids
	----------mg/l---------
Wind River near Dubois	105
Wind River at Riverton	205
Little Wind River near Riverton	390
Fivemile Creek near Shoshoni	1,240
Wind River below Boysen	460
Bighorn River at Lucerne	520
Bighorn River at Neiber	555
Bighorn River at Worland	600
Nowood River at Manderson	470
Greybull River near Basin	625
Shell Creek near Greybull	645
Bighorn River at Kane	620
Shoshone River below Buffalo Bill Reservoir	225
Shoshone River near Lovell	465
Shoshone River at Kane	695
Little Bighorn River near Hardin	478
Bighorn River near Bighorn	699
Clarks Fork River near Chance	107
Clarks Fork near Laurel	434

Compiled from:
Water resource records for Wyoming and Montana, part 2, water quality records, U.S. Geological Survey. Data furnished by Wyoming Water Planning Program.

to be the largest such springs in the world. Hot springs on the Shoshone River below Buffalo Bill Dam are quite mineralized. Saline waters from oil wells also contribute dissolved solids to the stream system of the basin. The Hamilton Dome and Elk Basin oil fields have a significant problem in this respect.

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Archeologists have discovered evidence that man inhabited portions of the basin as long as 9,000 years ago. Some important evidence of early activity is still visible on the surface. The Medicine Wheel is an early relic of unknown origin and purpose. From its place on a high promontory of the northern Bighorn Mountains one commands a tremendous view of the Bighorn Basin. The wheel is formed of stones laid side by side in a circle 78 feet in diameter. Six rock cairns 2½ feet high are around the rim of the wheel. Five cairns face inward toward the center of the wheel. The sixth faces outward, toward the rising sun. This site may be reached by automobile and is a popular tourist stop. Near Meeteetse, on the banks of the Greybull River, is a 30 foot long arrow, also formed by laying rocks side by side, which points toward the Medicine Wheel. The original purpose of these archeological ruins is not known.

Excavations in Mummy Cave near Cody indicate occupation as early as 7280 B.C. Mummy Joe, for whom the cave is named, was wrapped in a sheepskin garment. A salvaged piece places his burial in the year 734 A.D. All of the cultural layers give evidence that young mountain sheep were the principal food supply for the cave dwellers.

Indian tribes active in the basin in recent times included the Sioux, Crow, Cheyenne, Arapahoe, Shoshone, and Sheepeaters. They ranged along the foothills, using the basin for hunting grounds during the summer and fall. The Shoshones occasionally wintered near the Wind River Basin, but the Sheepeaters were probably the only tribe in permanent residence.

The first recorded entry of white man occurred in 1743 when Chevalier de La Verendrye passed through in search of a route to the Pacific Ocean. Others came in 1804 in search of furs and gold. The Lewis and Clark expedition came down the Yellowstone River in 1806. The next year John Colter was sent out alone from the Manuel Liza expedition to promote fur trade with the Indians. He went up the Shoshone River to above Cody and described the geyser activity at the mouth of the canyon there. He went north to Sunlight Creek, east and south to the west slope of the Bighorn Mountains near Thermopolis, and went south to the Riverton-Lander area. From there he traveled northwest up the Wind River, over Togwotee Pass, and into the Jackson Hole and Yellowstone Park area.

Ashley's fur traders came down the Wind River in 1827. Captain L. E. Bonneville's rendezvous of 1833 was on the Popo Agie River, and Nathaniel Wyeth came through the area the same year. In 1860 Jim Bridger led a war department expedition through the basin to Yellowstone Park. In 1864 Jim Bridger and John Bozeman blazed the Bozeman Trail from Fort Fetterman on the Platte River to Three Forks on the Missouri River. This trail crossed the Bighorn River at Fort C. F. Smith.

The gold diggings at South Pass and Atlantic City provided the State of Wyoming with its first population center away from the Union Pacific Railroad. This expansion spilled over into the Wind River Basin. In 1868 settlers formally set forth the boundaries of Fremont County and ordered the town of Lander to be laid out. This was the year of government treaties with the Crow Indians at Fort Laramie and the Shoshone Indians in the Green River area. The Shoshone were moved to the site of the present Wind River Indian Reservation. This upset the local settlers, and their action seems to have been more to assert state's rights than to organize local government.

These and other incursions, settlements, mining developments, and military actions were violently resented by the Indian tribes, particularly the Sioux, Crow, and Northern Cheyenne. The Sioux moved north, Custer's troops moved west, and the stage was set for the crushing climax. The fight between the Sioux tribes and Custer's troops near the present site of Crow Agency on the Little Bighorn River occurred June 25 and 26, 1876. Custer's troops were massacred, but this brought massive retaliation by the government. In 1877 Fort Custer was established near Hardin. Also, in 1877 Chief Joseph and his Nez Perce made their famous retreat over the mountains and down the Clarks Fork River before they were captured in northern Montana. The Northern Pacific Railroad was built along the Yellowstone River, and coal mines were opened near Red Lodge to fuel the locomotives.

Development from 1877 to 1890 was fairly slow, but in 1892 most of the western portion of the Crow Indian Reservation was opened for settlement. In 1894 the Carey Act was passed, allowing the development of public lands by the construction of irrigation works. Mormon colonies started moving into the Bighorn Basin. The Bridger Trail, an alternate to the Bozeman Trail, traversed the basin from south to north, and stagecoach routes were developed over the Bighorn Mountains from Buffalo and Sheridan. The Burlington Railroad was extended south from Toluca, Montana, in 1905. By 1908 Thermopolis had railroad service. The Wyoming and Northwestern Railroad Company built west from Casper to Shoshoni in 1906 and from Shoshoni to Lander in 1907. Surveyors from the Chicago and Northwestern Company surveyed a line through the Wind River Canyon that year, but work stopped at that point until 1913. In 1913 the Burlington Railroad purchased and used the earlier surveys, built through the canyon, and the basin had through train service.

The population explosion from 1900 to 1910 more than doubled the basin's population. Private irrigation companies assisted the settlement by developing the irrigation of more than 300,000 acres of land. Most of the present cities were founded, the present system of counties formed, and the location of most roads established by 1910.

Buffalo Bill Reservoir was completed by the Bureau of Reclamation in 1909, and federal reclamation projects were begun in the basin. A portion of the Riverton Reclamation Project was opened for settlement in 1926. More land was opened in the 1930's, but further development

An old tepee ring near the present Boysen Reservoir. Man inhabited portions of the basin as long as 9000 years ago.

The search for gold brought the first settlers into and around the basin.

PLATE 11

was postponed until after World War II. Additional land was settled in 1947, 1949, and 1950. Trouble developed in repayments, and some of this land was returned to public ownership for a time. This land has since been auctioned to private ownership again. Boysen Reservoir was completed in 1951. Yellowtail Dam near Fort Smith was completed in 1965. About 30 percent of the irrigated land in the basin is served by these and other smaller reclamation projects.

GENERAL DESCRIPTION

Numerous factors have influenced the economic development of the Wind-Bighorn-Clarks Fork Basin. Population, employment, and income are the more important economic indicators of the area as it exists currently. These elements are described historically, measured in terms of present status, and projected to 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, education, labor force, etc., are only described and shown historically.

In order to present an overview of economic activity and social characteristics for the area, published materials were utilized extensively. Data from secondary sources are generally not available for areas smaller than a single county or a group of counties. Therefore, five counties in Wyoming and three counties in Montana are considered to be representative of the basin and are used as the geographic unit for economic study. The five Wyoming counties are Big Horn, Fremont, Hot Springs, Park, and Washakie. Montana counties are Big Horn, Carbon, and Stillwater.

Population

Total population of the study area declined from 1920 to 1930; increased for the next three decades; and then decreased from 1960 to 1970. The 1970 population count was 90,176 following a high of 94,038 in 1960. Population has been declining in the Montana portion of the basin; however, population increases in the Wyoming portion more than offset the losses from 1930 to 1960, table III-1.

Although basin residents are predominantly rural, they are becoming more urban-oriented. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most sections of the United States. In 1970 nearly 40 percent of the population lived in urban areas (towns over 2,500) as compared to 17 percent in 1940, table III-2. Urban areas listed in descending order along with their 1970 population are as follows: Riverton (7,995), Lander (7,125), Cody (5,161), Worland (5,055), Powell (4,807), Thermopolis (3,063) in Wyoming and Hardin in Montana (2,733). None of these are large enough to be classed as a Standard Metropolitan Statistical Area.

The study area contained 31 incorporated communities in 1970 varying in size from 25 persons in Lost Cabin, Wyoming, and 31 people in Bearcreek, Montana, to the urban areas listed above. In table III-3 incorporated places

Table III-1--Total population of Wind-Bighorn-Clarks Fork study area

Area	1920	1930	1940	1950	1960	1970
	number					
Wyoming portion	39,493	39,504	50,447	60,440	70,188	68,407
Montana portion	29,924	27,367	27,978	25,481	23,850	21,769
Total	69,417	66,871	78,425	85,921	94,038	90,176

Source: U. S. Census of Population

Table III-2--Population by rural and urban categories, Wind-Bighorn-Clarks Fork study area

Category/Area	1940	1950	1960	1970
	number			
Urban:				
Wyoming portion	10,380	24,747	30,366	33,206
Montana portion	2,950	2,730	2,789	2,733
Urban subtotal	13,330	27,477	33,155	35,939
Rural farm:				
Wyoming portion	22,283	18,759	14,032	10,612
Montana portion	14,496	11,273	8,149	6,458
Rural farm subtotal	36,779	30,032	22,181	17,070
Rural non-farm:				
Wyoming portion	17,784	16,934	25,790	24,589
Montana portion	10,532	11,478	12,912	12,578
Rural non-farm subtotal	28,316	28,412	38,702	37,167
Total	78,425	85,921	94,038	90,176

Source: U.S. Census of Population

are listed according to their size class in 1970, thus revealing what changes have occurred since 1940. The rural orientation of this area is also disclosed by population density. There are about 2.8 persons per square mile in the eight-county area as compared to 3.4, 4.7, and 57.0 persons per square mile for Wyoming, Montana, and the United States, respectively.

The basin contains most of two Indian reservations--the Wind River in Wyoming and the Crow in Montana. In 1970, 9 percent of the total population

Those who found no gold began to settle the land. The sod-covered log house was the standard homesteader's residence.

This picture of a tar paper shack and serious wind erosion was taken in 1937 during the settlement of the Riverton Project.

In 1943 the tar paper shack remained, but a planted wind-break had helped heal the land.

PLATE 12

When repayment problems developed on a portion of the Riverton Reclamation Project, the land was purchased by the government; and some settlers abandoned their homes.

An "average" farmstead on an irrigated farm on the Riverton Reclamation Project. The windbreak of planted trees protects homes and reduces erosion.

PLATE 13

Table III-3--Population of towns by size class, Wind-Bighorn-Clarks Fork study area

Size class/area 1/	Towns	1940	1950	1960	1970
	--------------------number--------------------				
Less than 500:					
Wyoming portion	12	2,485	2,683	3,132	2,888
Montana portion	3	1,333	1,014	880	807
Subtotal	15	3,818	3,697	4,012	3,695
500-999:					
Wyoming portion	2	638	1,170	1,340	1,460
Montana portion	2	1,622	1,390	1,511	1,523
Subtotal	4	2,260	2,560	2,851	2,983
1,000-2,499:					
Wyoming portion	3	5,102	5,990	6,056	5,469
Montana portion	2	3,912	3,827	3,559	3,017
Subtotal	5	9,014	9,817	9,615	8,486
2,500-5,000:					
Wyoming portion	2	4,370	6,674	8,695	7,870
Montana portion	1	1,886	2,306	2,789	2,733
Subtotal	3	6,256	8,980	11,484	10,603
Over 5,000					
Wyoming portion	4	10,380	15,565	21,671	25,336
Montana portion	0	--	--	--	--
Subtotal	4	10,380	15,565	21,671	25,336
Total	31	31,728	40,619	49,633	51,103
Wyoming portion	23	22,975	32,082	40,894	43,023
Montana portion	8	8,753	8,537	8,739	8,080

Source: U. S. Census of Population

1/ Population of towns in 1970 determined size class for all years shown above.

and 13 percent of all rural inhabitants were Indians. The number of Indians increased from 6,972 in 1960 to 8,013 in 1970. Over 90 percent live in rural areas.

From 1960 to 1970, migration patterns have influenced population changes in the study area by a greater amount than births and deaths, table III-4. During this decade, a net out-migration occurred in all of the eight counties for a total of 14,629 people.

From 1940 to 1970, there was a natural increase of over 38,000 people; however, 70 percent of this increase was erased by out-migration. The loss of population through net out-migration during the 30-year period was about 27,000. This is greater than the combined population of the four largest towns in the study area.

Numerous side effects can be attributed to migration. Some of the age groups are affected more than others. A large proportion of those who migrate come from the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of the area and states' populations from 1960 to 1970 are as follows:

Age group	Percentage change from 1960 to 1970				
	Wyoming portion	Montana portion	Study area	State of Wyoming	State of Montana
75+	+30.9	+16.9	+26.2	+43.0	+33.4
65-74	+10.8	-11.7	+ 3.3	+ 4.0	- 9.7
55-64	+31.0	+17.3	+27.0	+16.8	+21.6
45-54	+ 1.8	- 6.7	- 0.5	+ 3.5	+ 6.2
35-44	-11.4	-23.9	-14.5	-12.0	-12.8
25-34	- 9.2	- 9.1	- 9.2	- 8.1	- 0.9
15-24	+15.9	+ 8.4	+14.0	+31.4	+34.9
5-14	- 3.7	-11.8	- 5.7	- 0.5	+ 4.7
Under 5	-33.8	-33.5	-33.7	-30.1	-31.4

The Indian population as a whole is quite young when compared to the non-Indians. In 1970, the median age of Indians in the area was about 20 years as compared to about 29 years for all inhabitants. About 62 percent of the Indian population is under 25 years of age as contrasted to 45 percent for the other inhabitants. The difference in age composition between white and nonwhites (primarily Indians) is shown in figure III-1.

Formal education for the rural farm and nonwhite populations is below a comparable figure for the area population as a whole. In 1960, median school years completed for persons 25 years old and over were 10.8, 10.6, and 8.6, respectively, for all residents, rural farm residents, and the nonwhites. By 1970, comparable educational levels were 12.0, 12.1, and 10.8, respectively.

Figure III-1--Population distribution in percentages by age group and race, 1960 and 1970--Wind-Bighorn-Clarks Fork study area

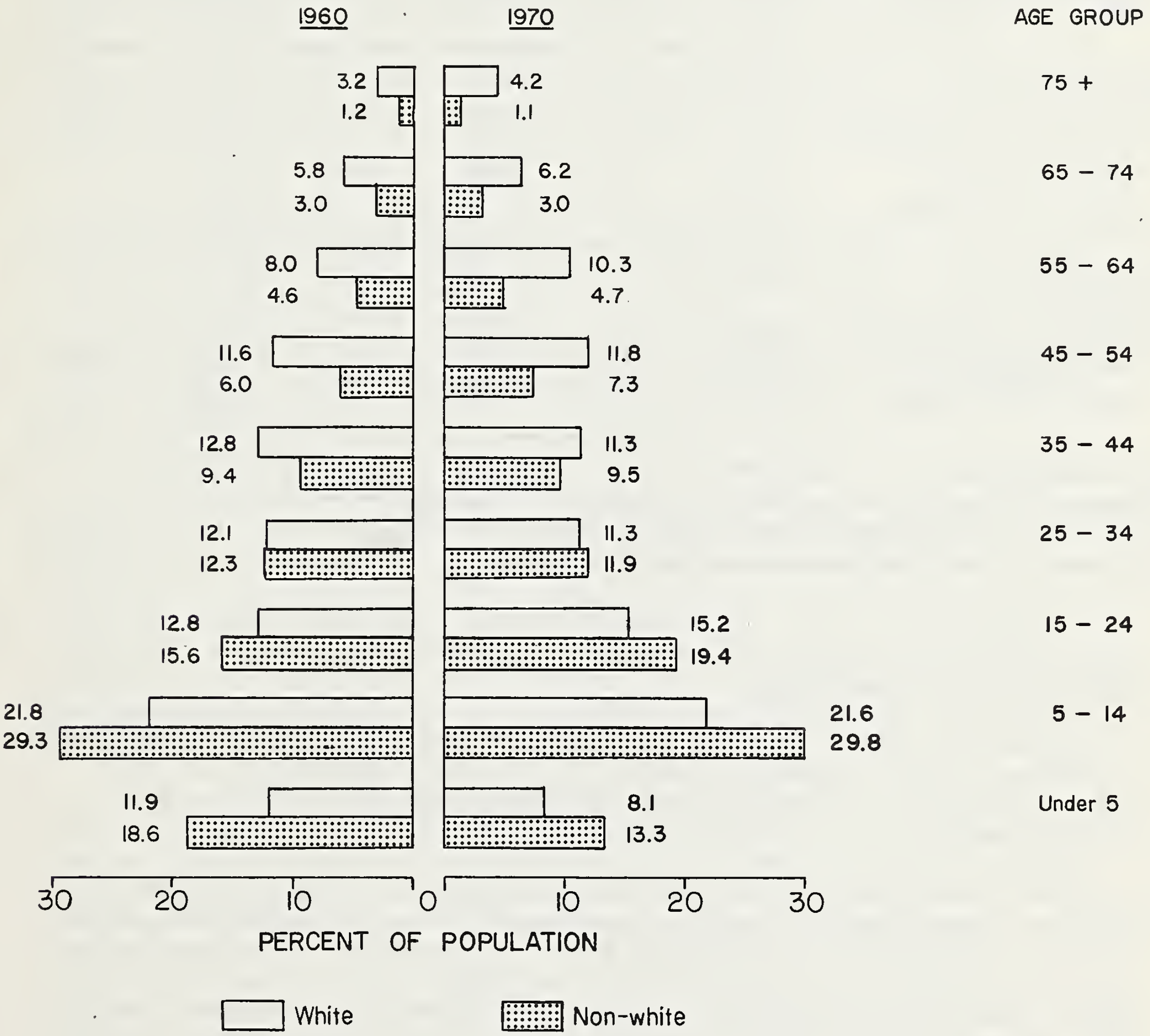


Table III-4--Components of population change, 1940-1970
Wind-Bighorn-Clarks Fork study area

Component	Wyoming portion		Montana portion		Total area	
	Number	Percent	Number	Percent	Number	Percent
1940 population	50,447		27,978		78,425	
1940-1950:						
Natural increase 1/	9,194		2,434		11,628	
Net migration 2/	799	+ 1.6	-4,931	-17.6	- 4,132	- 5.3
Population change	9,993		-2,497		7,496	
1950 population	60,440		25,481		85,921	
1950-1960:						
Natural increase 1/	12,823		3,467		16,290	
Net migration 2/	-3,075	- 5.1	-5,098	-20.0	- 8,173	- 9.5
Population change	9,748		-1,631		8,117	
1960 population	70,188		23,850		94,038	
1960-1970:						
Natural increase 1/	8,683		2,084		10,767	
Net migration 2/	-10,464	-14.8	-4,165	-17.5	-14,629	-15.6
Population change	- 1,781		-2,081		- 3,862	
1970 population	68,407		21,769		90,176	

1/ Births to resident mothers minus death of residents.
2/ Population change minus natural increase.

Labor force and employment

About 32.5 percent of the population of the Montana part of the basin is employed. This compares to about 35.2 percent employment for the State of Montana. In Wyoming the comparable figures are 37.0 and 37.1 percent.

The labor force includes all employed persons as well as those currently unemployed but seeking employment. About 57 percent of those 16 years old and older were in the labor force in 1970. Comparable labor force participation rates for Montana and Wyoming are 51 and 59 percent respectively. Most of the labor force is between 25 and 64 years of age. This age group is gradually becoming a larger part of the total as young people delay entry into the labor force due to educational opportunities and job training requirements. Improved retirement benefits are also attracting older workers to withdraw from the labor force. The 5 percent average unemployment rate in the study area is about the same as the national average unemployment rate.

There are numerous workers in the study area whose labor is under-utilized; thus, their income is less than what it might be. Underemployment differs from unemployment only in that human resources are partially utilized. An unemployed person cannot find work while an underemployed

person can find work, but at an amount less than he desires. Causes of underemployment are many and varied. When there is a lack of employment opportunities, some withdraw from the labor force rather than seek new jobs. Another cause is the immobility of people, especially those over 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the basin intensify this type of attitude for some workers. Fishing, hunting, and other outdoor activities are not readily sacrificed for added income. Also, many jobs are seasonal, leaving many unemployed or underemployed part of the year. Farming, food processing, mining, and recreational services may provide only seasonal employment. The tourist trade is limited almost entirely to the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine whether or not incomes are below capacity.[1/] County income capacities are measured by age, educational status, and other selected attributes of the labor force. They are compared with similar measures for the nation as a whole. In 1960, study area underemployment rates were 15 percent of the male labor force and 40 percent of the female labor force for a combined 21 percent of the total labor force. Severe underemployment exists at 20 percent or over. Underemployment rates are even higher on the Indian reservations.

The increase in population from 1940 to 1960 was closely related to the growth in nonfarm employment oppotunities. Total employment increased 33 percent during the period despite a continuing decrease in agricultural employment (table III-5). In 1970 total employment was 32,374. This was 263 less than a decade earlier. Employment in the Montana portion of the study has been on the decline during most of the last three decades while employment has been increasing in the Wyoming portion. It should be recognized that employees of agriculturally related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

Basic industries of the area include agriculture, forestry, mining, and manufacturing. In 1940, they provided 58 percent of all jobs; by 1970 only 34 percent. Agriculture-forestry is the only major industry where employment declined continuously over the 30-year period. Construction employment has declined since 1950 after one decade of fantastic growth. All other sectors generally have expanded since 1940.

Male employees accounted for only 500 more jobs in 1970 than in 1940. Meanwhile, female job holders increased 222 percent. One reason for this

---

1/ Income capacities were determined by comparing selected attributes of the male and female labor force in this study area to like attributes for the nation as a whole. Reported median incomes for the study area were then compared with an imputed median income which reflects the earning capacity of the labor force if incomes were the same as for the national labor force with similar earnings characteristics. Thus if reported income is less than imputed income, income is below capacity; such is the case in the study area. The ratio between these indicators measures the amount of underemployment.

Table III-5--Employment by industry--Wind-Bighorn-Clarks Fork study area

Industry	1940	1950	1960	1970	Percentage change			Percentage Distribution	
					40-50	50-60	60-70	1960	1970
Agriculture & forestry	12,388	10,951	7,660	5,511	- 11.6	- 30.1	- 28.1	23.5	17.0
Mining	793	1,681	3,128	3,041	+112.0	+ 86.1	- 2.8	9.6	9.4
Construction	1,307	3,330	2,474	2,189	+154.8	- 25.7	- 11.5	7.6	6.8
Manufacturing									
Food products	(350	(380)	(523)	(515)	+ 8.6	+ 37.6	- 1.5		
Lumber products	(212	(147)	(180)	(252)	- 30.7	+ 22.4	+ 40.0		
Other	(498	(806)	(1,085)	(1,669)	+ 61.8	+ 34.6	+ 53.8		
Total manufacturing	1,060	1,333	1,788	2,436	+25.8	+34.1	+36.2	5.5	7.5
Transportation, Communications, and utilities	915	1,909	2,228	1,910	+108.6	+ 16.7	- 14.3	6.8	5.9
Wholesale trade	349	561	539	819	+ 60.7	- 3.9	+ 51.9	1.6	2.5
Retail trade	2,610	3,954	5,227	5,582	+ 51.5	+ 32.2	+ 6.8	16.0	17.2
Finance, insurance, and real estate	242	603	687	808	+149.2	+ 13.9	+ 17.6	2.1	2.5
Services	3,591	4,584	6,706	8,136	+ 27.6	+ 46.3	+ 21.3	20.5	25.2
Government	823	1,212	1,394	1,942	+ 47.3	+ 15.0	+ 39.3	4.3	6.0
Not reported	387	493	806	0	+ 27.4	+ 63.5	N.A.	2.5	--
Total	24,465	30,611	32,637	32,374	+ 25.1	+ 6.6	- 0.8	100.0	100.0
Male	21,135	24,619	23,807	21,646	+ 16.5	- 3.3	- 9.1	72.9	66.9
Female	3,330	5,992	8,830	10,728	+ 79.9	+ 47.4	+ 21.5	27.1	33.1
Wyoming portion	15,953	22,001	24,790	25,289	+ 37.9	+ 12.7	+ 2.0	N.A.	N.A.
Montana portion	8,512	8,610	7,847	7,085	+ 1.2	- 8.9	- 9.7	N.A.	N.A.
State of Wyoming	86,559	114,715	123,309	123,389	+ 32.4	+ 7.5	+ 0.1	N.A.	N.A.
State of Montana	185,564	220,468	237,598	244,608	+ 18.8	+ 7.8	+ 3.0	N.A.	N.A.

Source: U.S. Census of Population

expansion is that farm women typically are not counted as a part of the labor force, although they may contribute significantly to agricultural output. However, as farm women seek off-farm employment or as they migrate from farms and obtain jobs, they are counted in the labor force. Secondly, there is a tendency for some women who have finished rearing their families to find jobs in service-type industries. More of these jobs are becoming available, and quite often they can be filled by workers with very little specialized training.

Economic activity in business and manufacturing sectors is shown in table III-6. Trends in the number of establishments vary by industry. Incomplete reporting of the dollar value of business activity somewhat obscures any trends.

Income

Personal income is another measure that can be used to reflect the economic well-being of an area. Total personal income for residents of the study area increased from 38 million dollars in 1940 to 286 million in 1970, table III-7. This is an increase of 660 percent as compared to 775 percent for the nation. Per capita income increased during the period. However, in 1970 it was 19 percent below the national average. Total personal income, after adjustment to a 1967 dollar base, is also shown in table III-7. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation.

Income per family in the study area is lower than for the states of Wyoming and Montana. Also, many of the counties have a larger percentage of families below the poverty level (as defined by census). Variations between areas and location of residence are shown as follows:

Area	Percentage of families with income below poverty level		
	All families	Rural nonfarm	Rural farm
Wyoming portion	10.6	11.7	13.7
Big Horn Co.	9.6	9.0	11.9
Fremont Co.	11.8	16.4	21.0
Hot Springs Co.	12.9	11.3	15.2
Park Co.	7.9	8.1	8.4
Washakie Co.	12.2	9.8	11.2
Montana portion	16.7	18.3	16.7
Big Horn Co.	21.4	31.6	21.0
Carbon Co.	14.3	15.5	11.3
Stillwater Co.	12.5	10.3	17.3
Study area	12.1	13.9	14.8
State of Wyoming	9.3	10.2	12.1
State of Montana	10.4	12.3	14.1

Table III-6--Number of business establishments and reported economic activity, 1958-67 Wind-Bighorn-Clarks Fork study area

Item	Unit	1958	1963	1967
Wholesale trade:				
Establishments	No.	186	168	164
Sales	$Million 2/	41.1	43.7	56.3
Retail trade:				
Establishments	No.	1,184	1,199	1,178
Sales	$Million 2/	106.8	126.0	127.6
Selected services:				
Establishments	No.	718	815	778
Receipts	$Million 2/	10.6	16.8	20.3
Mineral industries:				
Establishments	No.	320	343	238
Shipments and receipts	$Million 2/	251.1 1/	286.0 1/	264.9 1/
Manufacturing:				
Establishments	No.	98	112	100
Value added	$Million 2/	9.7 1/	16.5 1/	15.3 1/

1/Part of the data has been withheld to avoid disclosure of individual firms.

2/Current dollars.

Source: U.S. Census of Business; U.S. Census of Manufacturers

Table III-7--Personal income and earnings by broad industrial sector for selected years, Wind-Bighorn-Clarks Fork study area

Category	1940	1950	1959	1966	1968	1970
	thousands of dollars 2/					
Total personal income	37,637	117,693	169,693	218,736	246,635	285,946
Per capita income 1/	480	1,370	1,851	2,397	2,710	3,171
Wyoming portion	476	1,359	1,904	2,538	2,916	3,294
Montana portion	492	1,397	1,696	2,006	2,133	2,784
Per capita income rel. to U.S. = 100	81	92	86	81	79	81
Wyoming portion	80	91	88	86	85	84
Montana portion	83	93	78	68	62	71
Total earnings	32,803	98,308	139,666	174,652	194,885	220,879 4/
Farm earnings	15,210	36,056	31,472	30,568	31,168	29,842
Total nonfarm earnings	17,593	62,252	108,194	144,084	163,717	191,037 4/
Gov't earnings	4,997	11,682	20,885	33,674	39,091	47,157
Private nonfarm Earnings	12,596	50,570	87,309	110,410	124,626	143,880 4/
Manufacturing	1,399	4,800	5,835	11,811	14,698	18,387
Mining	921	5,023	18,919	21,694	26,701	30,228
Contract constr.	1,214	8,299	11,465	14,839	15,107	16,612
trans., comm., & public utilities	1,374	4,932	9,099	10,471	11,859	13,187
Wholesale and retail trade	5,230	18,348	24,944	25,207	26,510	29,508
Finance, insurance, and real estate	368	1,976	3,046	4,554	5,075	5,492
Services	2,056	7,095	13,440	20,739	23,520	28,484
Other	34	97	561	1,095	1,156	1,353
	thousands of dollars 3/					
Total personal income	94,565	162,335	191,743	224,345	238,064	253,051
Per capita income 1/	1,206	1,890	2,088	2,459	2,616	2,806

1/ Per capita income is shown in dollars.
2/ Current dollars.
3/ 1967 constant dollars.
4/ Includes \$629,000 of manufacturing and contract construction earnings not shown separately to avoid disclosure.

Source: Office of Business Economic Information System.

Wages, salaries, proprietors' income, and other labor income are combined and referred to as earnings. They account for 77 percent of total personal income in 1970. Total earnings are shown in table III-7. In 1940, farm earnings accounted for 46 percent of the total and then declined to 14 percent in 1970. Meanwhile, another basic industry--mining--(includes minerals and petroleum) had earnings that grew from 3 percent to 14 percent of the total. Although the local income is significant, total income from tourism and employment in services to tourists has not been separated from all services. Earnings from manufacturing and construction are relatively small, but this status may be altered in the near future as water conduits and industrial plants to support development of coal fields in and adjacent to the study area are developed.

Projections

Total population is projected to increase 54 percent by 2020 to a total of 138,700 people, table III-8. Meanwhile, the rural farm segment will continue to decline and will contain only 8 percent of all inhabitants by 2020. It is estimated that total population of the nation will double during this time. Total employment is also projected to increase. All of the increase will occur in nonagricultural sectors. Agricultural employment is projected at 4,450 in 1980; 3,600 in 2000; and 3,300 in 2020. Estimates of per capita income are also included in table III-8.

The above projections are somewhat governed by an extension of historical trends in major sectors of the area economy. Very recent developments in the mining industry may alter future conditions considerably. Large deposits of coal are known to exist in southeastern Montana and northeastern Wyoming including parts of the basin. The total resource is estimated in many billions of tons and much of it can be strip mined. Current annual production is very small in relation to the total resource. Production is increasing rapidly, and the potential for further development is favorable if large quantities of water are delivered to the coal fields.

How much the above projections will be affected by coal developments is a function of the type as well as the amount of development. If this resource is exported as a raw material, fewer employees will be required than if the coal is processed and exported as some other form of energy. The level of skills required of the employees will also vary according to the amount of processing done. This is turn may be reflected in per capita income. Very recent trends in the population growth of the nation are somewhat lower than the rates used for the projections in this report. A nationally consistent set of lower population projections for small areas were not available for use in this report.

Urban centers and transportation

In addition to the urban areas within the study area, two cities exert considerable influence upon the local economy. Billings, Montana, is located adjacent to the northern edge of the basin; and Casper, Wyoming, is about 50 miles southeast of the basin. Each of these cities has a

Table III-8--Projected population, employment, and per capita income, Wind-Bighorn-Clarks Fork study area

Item	1970	1980	2000	2020
Population:	90,176	97,100	116,200	138,700
Rural farm	17,070	14,400	12,200	11,300
Employment:	32,374	35,800	44,100	54,200
Agricultural	5,511	4,450	3,600	3,300
Other basic	5,477	6,000	6,300	6,200
Non-basic	21,386	25,350	34,200	44,700
Per capita income 1/	2,806	3,800	7,000	12,700
Per capita income relative to U.S. = 100	81	80	86	89

1/ 1967 constant dollars.

Source: OBE data and census data adjusted to local conditions.

sound, basic petroleum industry, wholesale outlets, small manufacturing, and transportation industries. Billings is also largely dependent on agriculture, as it provides a principal market outlet for agricultural products. It also lends stability to the surrounding area by providing some off-season employment to farmers.

There are community hospitals in most of the larger towns and more complete medical facilities in Billings. Most of the towns and some farms receive natural gas and electricity from power companies. The rest of the basin is served by rural electric cooperatives. Almost all of the town and farm residences have telephone service.

Interstate highways 90 and 94 are nearly completed in the basin. Other highways include U.S. 14, 16, 20, 26, 87, 212, 287, and 310, and many state highways. All of the larger population centers are served by one or more of the major highways. The main line of the Burlington Northern Railway crosses the north end of the basin. Branch lines of Burlington Northern and the Chicago and Northwestern Railroad also serve parts of the basin. Scheduled airline service is available at Cody, Riverton, and Worland, Wyoming. This service is not available in the Montana part of the basin, but several airlines serve Billings on regular schedules.

AGRICULTURE AND RELATED ACTIVITY

General

Agriculture is an important segment of the study area economy. Although the number of farms and farm operators is declining, agriculture is an expanding industry. It is expanding in terms of total value of production as well as product diversification. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides, and larger farm machinery. Further efficiencies are expected through the year 2020. Larger quantities of agricultural products will be required as population of the nation increases or as net exports increase. Rising per capita income leads to additional expenditures for many food items. As incomes expand, consumers tend to upgrade their diets, and this generally means eating more meat, especially beef. Beef cattle are the principal source of agricultural income. Most of the beef is sold as feeder cattle and calves. Cattle feeding is growing in importance toward the northern part of the basin. Expansion in cattle feeding will provide an outlet for silage and feed grains that are grown on land going out of sugarbeet production in the Montana portion of the basin. Sheep and lamb production is also important. Most lambs are sold for fattening outside the basin.

According to the Census of Agriculture, the amount of land in farms and ranches has remained fairly constant. In addition to these privately owned lands, livestock producers obtain grazing leases and permits for public lands, thus increasing the total amount of land used for agricultural production. Some of the characteristics of farms are subject to change (table III-9). Out-migration, particularly from the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from extensive livestock operations to those specializing in intensively irrigated row crops. In 1969, 20 percent of all units were less than 100 acres in size; and 27 percent were over 1,000 acres. About 75 percent of the land in farms is controlled by farms or ranches larger than 2,000 acres.

The per acre value of land and buildings nearly tripled between 1954 and 1969. This was partially due to higher land prices and building construction costs and partially due to other capital investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased size has resulted in an average investment of greater than $130,000 per unit. Large capital requirements are also reflected in type of ownership. Apparently, some of the operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Also, the returns to operating capital are often higher than the returns to capital invested in land. Little change

Modern Large feedlots are being developed in the Basin to utilize local feed for local cattle. (Yellowstone County above; Carbon County below)

Most of the dry cropland is stripcropped and some of it is protected with single-row windbreaks which also provide wildlife habitat.

BUREAU OF INDIAN AFFAIRS PHOTO

Dryland farming, by nature, is big enterprise farming.

PLATE 15

Table III-9--Characteristics of farms in the Wind-Bighorn-Clarks Fork study area

Item	Unit	1954	1959	1964	1969
Farms	Number	5,855	4,918	4,476	3,942
Average farm size	Acre	1,864	2,265	2,600	2,793
Ownership class:					
Full owner	Percent	51	45	46	48
Part owner	Percent	29	35	38	38
Tenant	Percent	20	20	16	14
Size class:					
Under 100 acres	Percent	21	17	16	20
100-179 acres	Percent	21	17	14	11
180-259 acres	Percent	11	11	10	9
260-499 acres	Percent	17	20	21	18
500-999 acres	Percent	11	13	14	15
Over 1,000 acres	Percent	19	22	25	27
Value of land and buildings:					
Per farm	Dollars 1/	30,558	48,973	82,332	131,025
Per acre	Dollars 1/	16	22	32	47

1/ Current dollars

Source: U.S. Census of Agriculture

can be expected in this trend as farm size, land values, and machinery costs continue to increase.

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugarbeet refineries, food processing plants, marketing, and transportation facilities are heavily dependent upon the crops and livestock produced locally. The amount of processing done locally varies between products. Processing can range from little, if any, for feed grains to providing a finished product, such as sugar. Farmers, ranchers, and their families are an important source of labor. They can supplement farm income with seasonal, part-time, and, in some cases, full-time jobs.

In 1969, 1,746 farm operators (44 percent of the total) reported that they worked off their farms. Twenty percent (801) of all farmers worked away from their farms at least 200 days in that year. An additional 8 percent has a similar status for 100-199 days.

Among those that reported working away from their farm, 1,189 operators maintain commercial farms, i.e., farms with agricultural product sales of $2,500 or more. Thirty-two percent of the commercial farm operators in the Montana study area that held jobs worked at these jobs 200 days or more per year. A comparable measure for the Wyoming study area is about 38 percent.

Land use and production

There are approximately 9.2 million acres of agricultural land in the basin that were inventoried during 1967 to determine use and conservation treatment needs. [1/] About 4.1 million acres are in the Montana portion and the remaining 5.1 million acres in Wyoming. Most of this privately-owned land is used to provide roughage, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Some additional land may be required for highways, urban, and built-up areas within the planning horizon of this study. The amount of agricultural cropland is expected to remain close to the present acreage. However, recent significant increases in international agricultural trade are resulting in reactivation of diverted acres and conversion of some rangeland to cropland. At present there are no projections available for future rates of the foreign trade or the degree of land use conversion. There is also expected to be some conversion of nonirrigated to irrigated cropland.

Irrigated crops that are grown include hay, sugarbeets, corn, small grains, dry beans, canning crops, silage, and pasture. Dryland crops are mainly wheat, barley, and hay. The production of corn for grain and silage is increasing and is used locally by feedlot operators. The acreage of dry beans has declined substantially in the entire basin. Competing areas

1/ Conservation Needs Inventory, Wyoming, 1967
Conservation Needs Inventory, Montana, 1967

have attracted dry bean and legume seed production away from the basin. The sugar beet acreages declined about 14,000 acres with the recent closing of the sugar plant at Hardin. Also, alternative crops are now more profitable to produce. In the Wyoming portion, malting barley has replaced much of the dry bean production. Malting barley is a relatively new crop to the basin, but a potential exists for further expanding production since the altitude and climate lend to growing a desirable product.

Barley, oats, and corn are used primarily as feed and marketed as livestock or livestock products. New high yielding and early maturing varieties of corn for silage have been developed for this area. Improved methods of storage have also enhanced production. Federal farm programs also influence land use.

There are about 763,000 acres currently irrigated and over 353,000 acres of cropland without irrigation facilities. Crop-fallow rotations are used for the dryland grain crops, primarily because of insufficient rainfall, but also due to federal agricultural policy favoring the practice. Present and projected cropland and range acreages are shown in table III-10. The amount of irrigated land is expected to increase 28,300 acres by 1980; another 30,500 acres by 2000; and another 35,300 acres by 2020. Total irrigated land is expected to be 857,000 acres in 2020. Nonirrigated cropland and rangeland will decrease slightly as a result of increased irrigation. Lands suitable for irrigation on public land may be available for future development through an exchange agreement. However, this was not considered in the projections.

Productivity per acre has been increasing and can be expected to expand further until 2020. Present and projected crop yields were calculated independently for the Wyoming and Montana portions of the basin as shown in table III-11.

Present and projected production for the major commodities is shown in table III-12. For most of the crops, <u>present</u> production is a weighted average for 1965-1970. The amount of grazing on public lands and Indian Reservations was obtained through the federal agencies issuing grazing leases and licenses. Currently, public lands provide 34 percent of the grazing resource. Production of livestock commodities was determined by relating current inventories and sales for the portions in each state to their respective state totals and then converting to units of weight.

Projected production from the basin is based upon the estimated national rate of increase (or decrease) for each commodity for each time period. These rates were altered upward or downward for some items through historical comparisons of significant trend changes between states. Corn for grain, barley, and oats were adjusted upward in both state portions of the basin. Sugarbeets were increased for the Wyoming portion. Downward adjustments were made for dry beans and some minor livestock commodities. Beef and sheep, the important items in the livestock sector, approximate the national rate. National projections of agricultural products are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses.

Table III-10--Present and projected land use on state and private land 1/--Wind-Bighorn-Clarks Fork study area

Crop	Present 2/	1980	2000	2020
	----------	acres	----------	
Irrigated cropland:	763,024	791,300	821,800	857,100
Wheat	12,000	10,900	10,000	9,000
Barley	54,200	68,000	78,000	83,000
Oats	31,200	25,200	22,700	21,200
Corn, grain	6,000	10,900	18,900	21,100
Sugarbeets	51,700	44,400	60,400	74,600
Dry beans	20,800	14,800	14,300	13,900
Vegetables 3/	1,500	1,000	1,200	1,300
Silage	28,500	34,800	38,000	40,000
Alfalfa hay	213,900	224,000	222,500	227,100
Other hay	137,000	137,000	137,000	137,000
Pasture	158,000	172,600	171,100	181,200
Other crops	8,500	8,500	8,500	8,500
Not harvested	39,724	39,200	39,200	39,200
Nonirrigated cropland:	353,592	341,800	349,900	349,000
Wheat	115,670	102,700	107,600	103,600
Barley	40,700	49,000	54,000	58,700
Oats	4,300	3,600	3,800	3,700
Hay	33,500	36,000	34,000	33,000
Fallow	159,422	150,500	150,500	150,000
Range	7,254,543 4/	7,238,050	7,199,450	7,165,050

1/ Does not include forested land and other uses.

2/ Present use of cropland generally represents a weighted average for 1965 through 1970.

3/ Mostly potatoes.

4/ Dry pastureland not included.

Most of the agricultural commodities produced in the basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in other localities or states. The significant aspects of cattle and sheep production are the cow-calf and ewe-lamb enterprises that provide feeders to feedlots. Projections of hay and grazing are based upon the amount of each needed to supply adequate roughage. The amount of roughage from grazing public and private ranges was added to the amount produced on irrigated land and from nonirrigated hay. It was assumed that any additional roughage would come from new hay, pasture, and silage crops. Consequently, most of the increase in irrigated acres is reflected in these roughage crops. One exception is beet tops. It is assumed that all sugarbeet tops are fed as silage or grazed.

Table III-11--Present and projected crop yields per harvested acre by subareas--Wind-Bighorn-Clarks Fork study area

Crop/Subarea	Unit	Yield per acre: Present	1980	2000	2020
Irrigated crops:					
Wheat-Wyoming	Bu.	38	42	54	66
Wheat-Montana	Bu.	41	47	59	72
Barley-Wyoming	Bu.	63	80	96	113
Barley-Montana	Bu.	53	74	93	106
Oats-Wyoming	Bu.	54	69	85	101
Oats-Montana	Bu.	62	80	99	109
Corn, grain-Wyoming	Bu.	69	85	96	108
Corn, grain-Montana	Bu.	71	93	115	135
Sugarbeets-Wyoming	Ton	17.0	19.9	24.5	29.4
Sugarbeets-Montana	Ton	16.6	20.1	24.1	29.1
Dry beans-Wyoming	Cwt.	16.4	20.1	25.2	30.0
Dry beans-Montana	Cwt.	16.5	20.1	23.9	27.6
Vegetables-Wyoming 2/	Cwt.	195	300	350	400
Silage-Wyoming	Ton	15.0	18.0	23.2	27.1
Silage-Montana	Ton	18.1	23.3	28.4	31.1
Alfalfa hay-Wyoming	Ton	2.8	3.2	3.7	4.3
Alfalfa hay-Montana	Ton	3.0	3.6	4.3	5.0
Improved grass hay-Wyoming	Ton	1.3	1.8	2.3	2.8
Native hay-Wyoming	Ton	1.1	1.3	1.6	2.0
Other hay-Montana	Ton	2.4	2.8	3.4	4.0
Permanent pasture-Wyoming	F.U. 1/	1,680	1,980	2,240	2,470
Rotation pasture-Wyoming	F.U. 1/	2,330	2,690	2,970	3,220
Pasture-Montana	F.U. 1/	2,100	2,520	2,940	3,360
Nonirrigated crops:					
Wheat-Wyoming	Bu.	24	30	39	48
Wheat-Montana	Bu.	27	32	36	42
Barley-Wyoming	Bu.	27	34	42	50
Barley-Montana	Bu.	35	40	47	55
Oats-Montana	Bu.	37	42	49	56
Hay-Montana	Ton	1.3	1.6	1.8	2.0
Range-Wyoming	F.U. 1/	123	157	183	198
Range-Montana	F.U. 1/	100	120	141	160

1/ Feed Unit: One feed unit is equivalent to one pound of shelled corn.

2/ Mostly potatoes.

Table III-12--Current and projected production and values of production--Wind-Bighorn-Clarks Fork study area

Crop	Unit	Current	1980	2000	2020
Wheat	Bu.	3,601,330	3,785,400	4,456,900	4,998,000
Barley	Bu.	4,711,670	7,304,000	9,967,000	12,463,000
Oats	Bu.	1,880,960	1,925,000	2,158,000	2,373,000
Corn, grain	Bu.	420,210	981,000	2,078,000	2,684,000
Sugarbeets	Ton	874,460	885,400	1,475,900	2,189,300
Dry beans	Cwt.	341,220	297,000	356,000	410,000
Vegetables 6/	Cwt.	292,500	300,000	420,000	520,000
Silage	Ton	469,400	721,400	985,600	1,171,800
Alfalfa hay	Ton	611,340	742,800	862,600	1,022,000
Other hay	Ton	272,500	347,200	421,700	499,200
Pasture	AUM 2/	641,133	825,373	934,593	1,096,609
Range	AUM 2/	1,517,751	1,903,804	2,219,578	2,438,751
Range 4/	AUM 2/	1,119,858	1,127,084	1,182,444	1,182,444
Beef	Lb. 1/ 3/	193,110	261,820	353,700	463,711
Pork	Lb. 1/ 3/	12,684	14,520	16,900	20,000
Sheep	Lb. 1/ 3/	18,947	16,230	19,310	22,380
Wool	Lb. 1/	3,600	3,084	3,670	4,252
Milk	Lb. 1/	70,000	61,200	68,600	77,800
Eggs	Doz. 1/	2,715	2,615	3,080	3,637
Poultry	Lb. 1/ 3/	522	527	625	738
Aggregate value of production	Dol. 1/ 5/	125,501	154,339	199,540	249,183
Value of feed utilized	Dol. 1/ 5/	50,322	63,302	76,302	88,205
Gross value of production	Dol. 1/ 5/	75,179	91,037	123,238	160,978

1/ Units in thousands.

2/ One feed unit has the equivalent feeding value as one pound of shelled corn. One animal unit month (AUM) = 450 feed units.

3/ Live weight basis.

4/ Grazing obtained through leases and licenses administered by federal agencies.

5/ Price standards from "Interim price standards for planning and evaluating water and land resources, Water Resources Council, April 1966," were used to the extent possible.

6/ Mostly potatoes.

Corn for silage and grain is increasing in importance.

Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management. (Clarks Fork Valley)

Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuited for irrigation under conventional systems.

About 6,000,000 cubic feet of industrial wood products came from the basin in 1962.

U.S. FOREST SERVICE PHOTO

By 1980 the demand for the basin's timber products is expected to exceed the supply by 3,000,000 cubic feet per year.

Currently, the amount of grain fed is in excess of production. Feed grain production is projected to increase 46 percent by 1980, 113 percent by 2000, and 150 percent by 2020. It is likely that the deficit will continue at least through 1980. Sugarbeet production will increase slightly by 1980 and increase 2½ times by 2020. Also by 2020, wheat and dry beans will increase 40 and 20 percent, respectively, over current production. Beef production is projected to increase 35 percent by 1980 and 140 percent by 2020. Sheep and milk production will decline by 1980 and then increase.

There are nmmerous considerations inherent in making projections for any commodity or geographic area. The foregoing projections are based upon national trends that are adjusted for local conditions. The demand for goods and services produced by water and land resources of the basin is influenced by market conditions in other areas. A large part of the agricultural output is exported as intermediate or final products that will eventually be consumed outside of the basin. The agricultural commodities produced are not unique to this basin, as they are also produced in competing areas throughout the nation and the world. Consequently, local producers have little command over the prices for the products and services they provide.

The heavy reliance upon nonlocal markets combined with the competitive nature of goods and services produced imposes some important economic restrictions upon the extent of agricultural production. Projections of production for the basin reflect expected shares of the nation's output that will clear the market at current normal prices. If an excess is produced and marketed at the national level, the major effects will include either a decline in prices or an accumulation of surpluses. Large production increases may affect market prices to the extent that returns to agriculture are less than conditions prior to the expansion phase.

However, a change in demand for agricultural commodities at the national level will have a similar effect at the local level. Recently there has been a significant increase in international trade. If the increased demand for agricultural products from the U.S. continues, there will likely be a production increase in this basin.

There is the possibility that technology will not be available to increase crop yields to the extent as shown in the projections. If future cropland yields are overestimated by 10 percent, an additional 77,000 acres of irrigated and 19,000 acres of nonirrigated cropland would be needed by 1980 to provide the same level of output. By 2020, irrigated and nonirrigated cropland acreages would be 82,000 and 20,000, respectively, above their current levels. If future cropland yields are underestimated, then less than the projected area of new cropland will be required to provide the same level of output.

The importance of public lands as a source of grazing was indicated earlier. It is assumed that most of the public land will continue to be available to livestock producers. However, if this resource becomes no longer available, additional production from private lands will be essential. Over 183,000 acres of irrigated pasture would be required to replace the grazing on public lands in 1980. By 2020, about 150,000 acres of irrigated pasture could replace grazing on public land.

FOREST RESOURCES AND RELATED ECONOMICS

Timber

In 1970 the Forest Service and other agencies cooperated with the Office of Business Economics (OBE) and the Economic Research Service (ERS) to produce a national assessment of water and related land resources. One result is a projection of national timber supplies and demands to the year 2020, with intermediate projections for 1980 and 2000. The national projections were allocated to major water regions and to subbasins. Use of the projections enables planners to identify the share of national demands which the subbasin is expected to provide and to compare prospective supplies to the demands. In 1962, the base year of this assessment, 1/ the estimated volume of growing stock available was about 12 million cubic feet. In the same year the basin produced about 6 million cubic feet of industrial wood products.

By 1980 the demand for timber products is expected to exceed the supply by 3 million cubic feet or nearly 12 percent. The demand will continue to outstrip the supply by an increasing margin for the remainder of the time period of the study if current levels of management, market prices, and other conditions remain constant or maintain current trends in change (table III-13).

Table III-13--Projected annual volume of growing stock available 1/ and demand, 1980, 2000, and 2020--Wind-Bighorn-Clarks Fork River Basin, Montana and Wyoming

Year	Supply of available growing stock	Projected demand of domestic roundwood
	---million cubic feet---	
1980	23	26
2000	31	45
2020	31	51

1/ Net volume of growing stock trees available for harvest.

Source: U.S. Forest Service and OBE-ERS data prepared for the National Assessment of Water and Related Land Resources, July 1970 and revisions of June 1971.

Currently, the national forests are contributing about 66 percent of the total timber harvest in the basin. About 28 percent comes from

1/ The boundaries of the subbasin used in the assessment are not exactly identical with the boundaries defined in this report; however, the area of commercial forest land is approximately the same.

the Indian Reservations. The rest comes from public domain, state, or private forests.

In 1971 approximately 220 persons were employed by the logging and forest products manufacturing firms in the basin. The volume of timber processed in the basin is about equal to that harvested in the basin.

Outdoor recreation

National forest lands within the basin are significant suppliers of outdoor recreation sites. In 1970 there were approximately 3,240,000 visitor-days use on these areas. The major activities were sight-seeing, camping, resort use, hunting, and fishing.

It is easy to recognize that such an influx of recreationists has an important impact on the local economy. However, measuring this impact is difficult. One method is to estimate the average expenditures per visitor day. These expenditures will mainly occur in food markets, service stations, drinking and eating places, and apparel, gift, or sporting goods stores. A California recreation study 1/ estimated that campers, day-users, motel and lodge guests, and mountain-home occupants averaged per capita daily expenditure of \$1.48, \$1.62, \$8.95, and \$1.76 respectively. The study also estimated the distribution of average expenditures by type of sector.

Sales to visitors do not represent the entire impact of expenditures on the local economy. The total impact of the recreation, as part of the economic base, must include those values of sales affecting the local economy in terms of personal income and employment generation. However, the other components of the economic base which include agriculture, forestry, mining, and manufacturing also have similar multiplier effects. In fact, of these components, the recreation industry generally is characterized by lower multiplier values.

Recreation participation is expected to increase substantially by 2000 and 2020 because of population growth and greater participation rates. The socio-economic factors identified as being closely associated with recreation participation rates are income, age, education, occupation, place of residence, amount of leisure time, and gender. The supply will depend upon many factors. Some influencing factors are land capabilities, available financing, expected prices or returns, and government policies.

Recreation use in visitor days (12 hours of recreation activity) does not indicate the number of times that a particular activity was enjoyed. For example, it is assumed that one visitor day of picnicking may represent six people having one 2-hour picnic or one person having six 2-hour picnics. However, only one picnic unit can be occupied for each picnic. Also, the

---

1/ R. Drake, et. al. Selected Economic Consequences of Recreation Development: Tuolumne County, Case Study, Agricultural Extension Service, University of California, Berkeley, No. 68-4, June 1968, 66 pp.

analysis of supply in visitor days assumes that a particular reaction unit is available for use during 12 hours each day, but a picnic table might be used only once (2-hour period) during a day. As much as 80 percent of the total use may occur during weekends and holidays. Striving to meet these peak demands with conventional facilities is economically inefficient due to the large percentage of idle capacity during the remaining periods.

RELATIONSHIP BETWEEN ECONOMIC DEVELOPMENT AND WATER RESOURCE DEVELOPMENT

Land and water resource developments for use in agricultural production were virtually unknown in the basin until the 1880's and 90's. The first were irrigation works built by individual farmers followed by developments made possible through the Carey Act. During this time, some of the land was denuded of its virgin cover and planted to vegetation that had water requirements greater than the amount available through the normal supply of rainfall. Sugarbeets, dry beans, alfalfa hay, and feed grains were no longer alien to this arid basin.

Crop production from irrigated lands became a progressively larger share of total agricultural production as more areas were irrigated. Currently, about two-thirds of the value of the basin's agricultural output can be attributed to the irrigated croplands. Both private and public investments have been put to use during the era of irrigation development. About 30 percent of the irrigated land has been developed as the result of federal reclamation projects. The remaining developments are about 10 percent in projects sponsored by the Bureau of Indian Affairs, and about 60 percent in private projects by individuals and by groups.

RESOURCES FOR RECREATION

Nearly all of the public and most of the private land and water areas in the basin are available for outdoor recreation. Trespass laws and other laws generally require the landowner's permission to use private lands for this or any purpose. User fees are often charged for the use of both private and public property or facilities. Profit and nonprofit indoor recreation facilities are generally available in the basin's larger towns.

The income from recreation activities in the basin is reflected in Table III-7, mainly in the entries for "Services" and "Other." Some of the "Wholesale and retail trade" is also the result of recreation activities. There is no way of knowing for sure, but the income to the basin from outdoor recreation is probably about $10,000,000 per year. Thus, it would rank first among the services and behind government, mining, wholesale and retail trade, construction, manufacturing, agriculture, and utilities and ahead of forestry as an income category.

To avoid unnecessary duplication in this report, most of the discussion about recreation is presented in Chapter V.

Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS

PLATE 18

WYOMING TRAVEL COMMISSION PHOTO

Winter recreation use of national forest lands is rapidly increasing.

SCS PHOTO

PLATE 19

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

The water and related land resources of the basin are affected by both natural and people-made processes which tend to reduce the quantity and quality of those resources. Other problems are caused by an imbalance of resource availability (primarily water shortages). This chapter discusses some of these processes and imbalances, the problems they create, their magnitude, and effect.

EROSION DAMAGE

Erosion damages occur in varying degrees throughout the basin. The most serious types are streambank and gully erosion. Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks in the soft sedimentary formations which compose most of the basin floor and the alluvium along the valley bottoms. Some of this erosion has occurred because modern man disturbed the vegetation and water flow patterns in the basin.

Erosion is also a problem in mountain forest and rangelands when disturbed, because soils are generally young, thin, and have little structural development. About 125 miles of gullies, 4,100 acres of accelerated sheet and gully erosion, 30 miles of eroding streambanks, 270 miles of eroding roads and trails, and 85 acres of eroding mine areas have been inventoried on national forest lands. Many miles of inadequately maintained trails are a problem in the forested lands of the Wind River Indian Reservation.

Sheet and rill erosion damages are not serious problems in the basin, but they do occur. They result from both high winds and high flows of runoff water over inadequately protected soils. These damages have been accelerated by overgrazing rangelands and through improper cultivation practices on croplands.

Major causes of erosion damage are (1) high rates of runoff and streamflows in the spring and early summer, (2) sparse vegetative cover, (3) improperly located roads and trails, (4) inadequately constructed logging roads and skid trails, (5) off-road vehicular travel, (6) overgrazing, (7) wildfires, and (8) mining.

The economic and social costs of accelerated erosion include loss of productive land, reduced crop production, damaged fish and wildlife habitat, damaged recreation sites, decreased farming efficiencies, damaged structures, reduced land values, interrupted utility lines, and reduced aesthetics. However, much of the visible erosion in the basin is natural or geologic erosion which hasn't changed much since the days of John Colter or Jim Bridger. At present there is not an economical way to control this erosion significantly; and it may not be the best thing to do, since many of these areas are colorful and scenic. Most of these areas remain in public ownership.

SEDIMENT YIELD AND DAMAGES

Sediment damages are generally light, but do occur with varying severity throughout the basin. Agricultural lands, stream and river channels, water supplies, capital improvements, reservoirs, fish, wildlife, and aesthetic values of streams are all damaged by sediment. Most of the damage occurs in the floor of the basin, and most (about 78 percent) of the sediment source is from the same area. Figure IV-1 is a sediment yield map for the basin.

Most sediment damages to agricultural lands occur in the irrigated valleys. Nearly all of this sediment damage is associated with flooding, from both perennial and intermittent streams. At the same time, irrigation canals and structures trap sediment, and their transport capacities are reduced. Cleaning and repairing these canals increases crop production costs. About 20 percent of the total length of these canals is cleaned each year.

Aggradation occurs in some portions of streams due to an over-supply of sediment from the eroding portions. This reduces their capacities and increases flooding. It also promotes stream meandering, which causes increased streambank erosion and land loss in a repeating cycle down the stream.

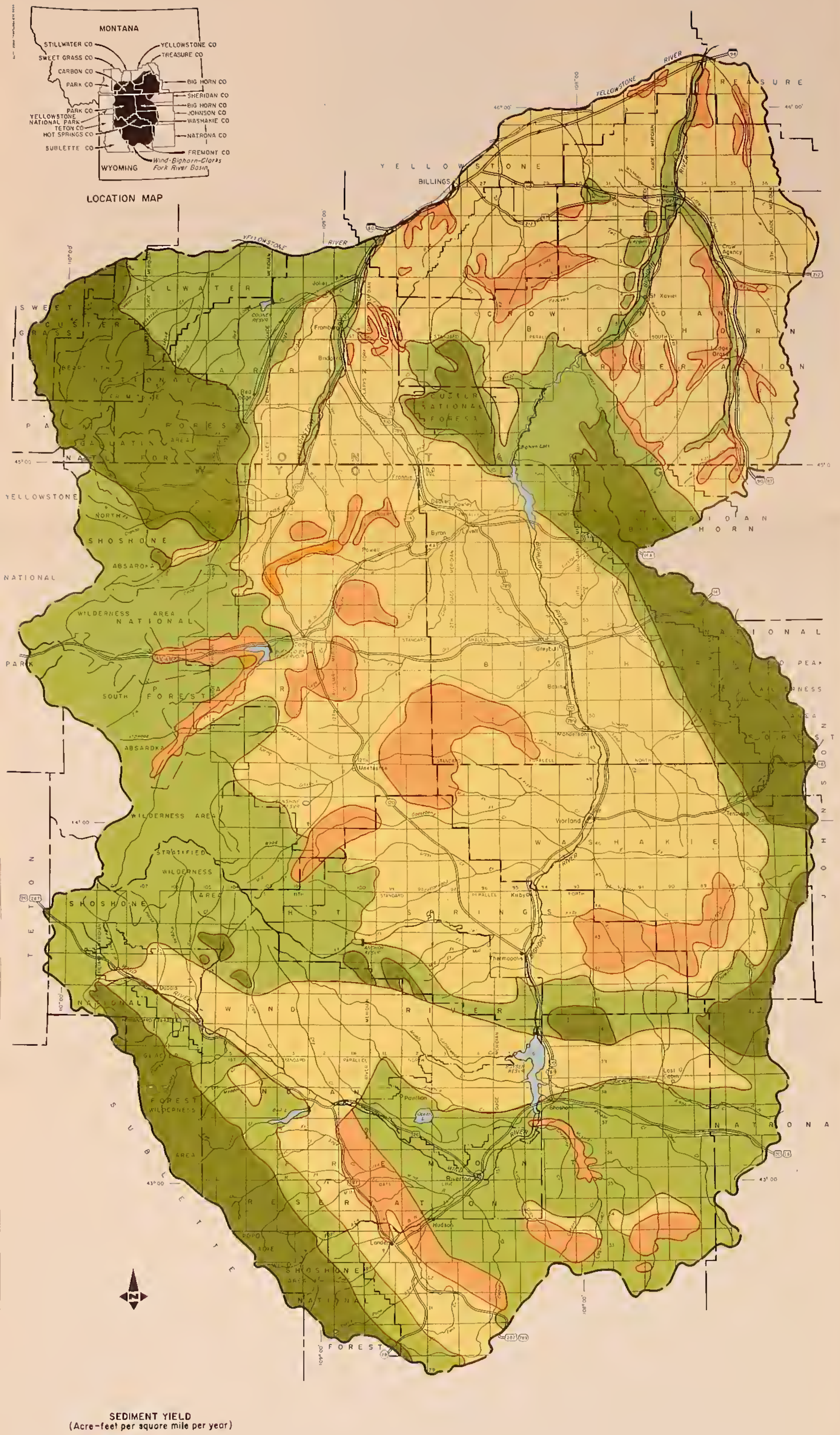
Suspended sediment loads in streams reduce water quality for irrigation, municipal, domestic, and industrial purposes. Some provision for filtering or settling out sediments must be provided in every municipal water treatment plant. The operation costs go up as sediment loads increase.

Sediment in streams can injure or kill fish and reduce fish reproduction by covering spawning beds. Other aquatic life may be similarly affected. This problem is serious enough on Clarks Fork River, below Big Sand Coulee, to attract the attention of fisheries biologists, fishermen, and other citizens and officials. Sediments originating from marine shales also carry undesirable salts into streams, stockwater reservoirs, and croplands, lowering the quality of the water for all downstream uses.

Reservoir capacities are reduced by the deposit of sediments. Table VI-1 lists estimated average annual sediment loads to selected reservoirs in the basin.

FLOODWATER DAMAGES

In general, historical data from field interviews and old newspaper stories do not indicate sufficient economic damage from floods to justify single-purpose flood prevention projects. Most flood damages occur on sparsely inhabited cropland areas on tributary streams. Mainstem flood damages are significantly reduced through the operation of large reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake. Levees and channel works have reduced flooding in some urban areas. Table IV-2 gives a brief resume of newspaper records of floods and the watersheds in which they occurred.



SEDIMENT YIELD
(Acre-feet per square mile per year)

- 1.0 – 3.0
- 0.5 – 1.0
- 0.2 – 0.5
- 0.05 – 0.2
- Less than 0.05

FIGURE IV-1

SEDIMENT YIELD
WIND · BIGHORN · CLARKS FORK RIVER BASIN
MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

M7-N-22441L

Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks.

Inadequate control of irrigation tailwater can cause gully erosion.

Checking the depth of sediment deposits in Boysen Reservoir.

PLATE 20

Sediment accumulation of 36 years has reduced the storage capacity and attractiveness of Cooney Reservoir in Carbon County.

Overuse of stream bottom has destroyed browse and game habitat.

USDA - FOREST SERVICE PHOTO

Streambank erosion of sandy soils along Elbow Creek.

Permeable log jetties constructed on the Bighorn River in an attempt to control bank erosion.

PLATE 21

Table IV-1--Sediment yields to selected reservoirs based on suspended load and/or reservoir surveys, Wind-Bighorn-Clarks Fork River Basin

Reservoir name and subbasin	Drainage area above reservoir	Sediment yield average annual	
		Total	Per square mile
	(square miles)	acre-feet	acre-feet
Boysen Reservoir	7,767	1,398	0.18
Bighorn Reservoir			
Bighorn River	8,598	3,525	0.41
Shoshone River	1,492	746	0.50
Buffalo Bill Reservoir	2,023	708	0.48

Source: River basin planning staff files

Floods have caused damage to crops, livestock, bridges, roads, machinery, fences, farm buildings, and homes. Residential areas have been flooded in the towns of Lander, Hudson, Thermopolis, Worland, Greybull, Red Lodge, Lodge Grass, and along Blue Creek.

The town of Lander has had at least two serious floods in recent years. Because of the threat of flooding, the city has taken action to improve the hydraulic characteristics of the river channel through the city. The town probably spends more each year to prevent flooding than any other town in the basin. As long as this practice is maintained and new buildings are kept out of the floodplain, only very rare floods can cause serious damage.

Both the Nowood and Bighorn Rivers have caused flooding in the small town of Manderson. Average annual damages are about $39,500. The water wells for the town of Joliet were flooded in 1964. As a partial result, new wells were drilled outside the flooded areas. The town of Fishtail often receives winter flooding caused by ice build-up in West Rosebud Creek during the fluctuating operations of the Mystic Lake Power Plant by the Montana Power Company.

Table IV-3 lists estimated average annual flood damages on selected drainages in the basin. Estimates of total flood damages in the entire basin were made for the Missouri River Basin Comprehensive Framework Study for present and projected economic conditions. Areas subject to flooding are listed in table IV-4.

Table IV-2--Occurrence of major floods, selected watersheds, 1960-1970

Watershed	Year										
	60	61	62	63	64	65	66	67	68	69	70
Crow Creek				M 1/		S 2/					
Little Popo Agie River			S	S		S				M	
Candy Jack Watershed	S		S	S				S			
Badwater Creek				M				M	S		
Nowood River			S	M		M		S			S
Greybull River		M	M	S	M	S		S	M	M	M
Shell Creek		S	S	S	M	S		M	S	M	M
Shoshone River		S	S	S		S		S	M		
Fishtail				M				S	S		
Blue-Duck Creek				S	S	S				S	
Pryor Creek				S	S	S					
Clarks Fork-Ruby Creek					S						
Red Lodge-Rock Creek			S	M				S	S		
Two Leggins				S				S			
Lodge Grass Creek						S				S	

1/ M = Moderate flooding. These floods were serious enough to be reported in local newspapers.

2/ S = Serious flooding. These floods were serious enough to merit special effort in reporting by the editor of the local newspaper. Compiled from field interviews and local newspaper accounts.

Table IV-3--Estimated average annual flood damage on selected drainages

Drainage area name	Floodplain area	Average annual damages 1/					
		Crop and pasture	Other agri-cultural	Other rural	Urban or residential	Indirect	Total
	---acres---	---dollars---					
Wyoming							
Crow Creek	40	170	9,580		0	980	10,730
Little Popo Agie	2,300	16,750	8,650		5,200	3,300	33,900
Upper Badwater	250	420	880		0	130	1,430
Nowood River	5,900	26,000	39,000		39,510	12,430	116,940
Subtotal for Wyoming	8,490	43,340	58,110		44,710	16,840	163,000
Montana							
Stillwater River Sub-basin	3,400	2,400		6,100	5,000	N/A	13,500
Clarks Fork Sub-basin	15,200	20,400		33,500	16,000	N/A	69,900
Bighorn Sub-basin (Incl. Little Bighorn)	32,500	30,100		42,900	58,400	N/A	131,400
Yellowstone minor tributaries	29,800	53,600		80,300	104,600	N/A	238,500
Subtotal for Montana	80,900	106,500		162,800	184,000	N/A	453,300

1/ Price Bases: Wyoming portion - 1970. Montana portion - Urban and "other rural" - 1960; Crop and Pasture - 1964

Sources: Wyoming portion: River Basin Staff analysis of selected watersheds.

Montana portion: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff analysis.

Table IV-4--Summary of current and projected flood damages

State portion	Area subject to flooding	Average annual flood damages 1/			
		Under current economic development	Under projected economic development without flood protection 2/		
			1980	2000	2020
	1,000 acres	1,000 dollars	1,000 dollars		
Wyoming	132.5	469.0	787.0	1,461.0	2,628.0
Montana	80.9	453.3	577.7	990.5	1,720.8
Total	213.4	922.3	1,364.7	2,451.5	4,348.8

1/ Price base: 1964 price base for agriculture, 1960 price levels for urban and other rural areas.

2/ Wyoming portion uses MRB data adusted to reflect recent population projections. Montana portion used projection coefficients from MRB study.

Source: Documentation data for Missouri River Basin (MRB) Comprehensive Framework Study.

The town of Lander had serious floods before the river channel was cleared. The threat of an occasional flood still exists.

Floods in urban areas disrupt business as well as damage property.

PLATE 22

Floods in rural areas damage roads, buildings, and cropland.

IMPAIRED DRAINAGE

When the ground-water table is less than 6 feet deep, vegetation is usually affected. One effect may be a reduction in crop production. Water tolerant, saline tolerant, and phreatophytic plants may invade as other plants are drowned out. The effects vary with soil types. Water tables only 3 feet under the surface of sandy soils may have fewer adverse effects than 6-foot water tables in some clay soils. If the water table is on or very near the surface much of the time, the area becomes a marsh. While these marsh areas are of little use to agriculture, they are particularly valuable to wildlife.

Wetland areas with intermediate water table levels are of reduced value to both wildlife and agriculture. A salinity problem is often associated with these lands. Above the water table a moist capillary zone develops. The moisture in this zone fluctuates with the water table and with surface water received from irrigation or precipitation. Large amounts of water are evaporated, leaving saline solids in and on the soils. These are not leached out through downward movement of water, and the soils may become so saline that most vegetation and animal life is eliminated. It is these wet and saline lands that constitute a problem, especially when associated with agricultural lands.

In these lands the primary causes of impaired drainage are layers of soil which restrict the movement of water, excessive application of irrigation water, surface and subsurface tailwaters from higher elevation irrigated areas, and seepage from canals and ditches.

There are about 47,900 acres in Montana and 98,000 acres in Wyoming of wet and/or saline lands in the basin with water tables less than 6 feet from the surface.

Figure IV-2 is a map of impaired drainage problem areas in the basin.

WATER SHORTAGES

Agricultural

Most irrigated lands are dependent on streamflows for their water supply. However, streamflow supplies are not generally concurrent with irrigation demands. Most of the streamflow is dependent on snowmelt from higher elevations. Climatic conditions are such that the crop growing season in the lower elevations begins before high elevation snowmelt and continues after most of the snow has melted. The peak streamflow occurs as much as 10 weeks before the crops reach their peak water use rates, and streamflows recede more rapidly than use rates. The timing or temporal problem that results is illustrated in figure IV-3 which shows rather typical demand and supply curves for areas tributary to the main stem of the large streams. Some of these streams are so short of water that storing all available water and using it at near 100 percent efficiency would still not provide a full water supply for presently irrigated lands. This is because landowners have developed their lands, systems, and crops to spread

early high streamflows as far as possible, even though the crops suffer greatly reduced yields later in the season when there is little water available.

In areas where water supplies are seasonally short, increased irrigation efficiencies would increase crop production and allow the irrigation of more land later in the irrigation season. Downstream water quality would probably be improved through reduction of sediments and dissolved solids in surface and subsurface return flows. However, the net effect on the quantity of water downstream is likely to be minimal or even negative.

The economic incentive to increase irrigation efficiencies will be greater if supplemental late season water is suplied through storage, transfer, or ground-water development. However, storage site locations are limited in much of the area because of geologically unfavorable or other expensive conditions. Also, large water transportation projects are expensive and are limited as to potential locations. Ground-water development is limited by the availability of aquifers, their yield rates, and their quality of water.

The supply problem is less on larger streams where existing flows can generally supply the needs of presently irrigated lands. Large reservoirs such as Boysen, Buffalo Bill, and Bighorn Lake generally provide adequate seasonal supplies of water for the lands they serve. However, some water shortages still exist in these areas because of on-farm and delivery system inefficiencies and late season shortages in the very dry years. Improved irrigation efficiencies in these areas may result in significant increase in downstream water supplies, improved water quality, and increased crop production.

Table IV-5 lists water shortage problems in the basin by major subbasins in each state for 50 and 80 percent chance years. The total shortage is shown in the table as a need for stored or transferred water. These data are for presently irrigated lands at present project efficiencies. All water available and not presently diverted was considered storable, whether or not specific reservoir sites were identified. If the storable water did not supply the deficit between diversion requirements and present diversions, the remaining deficit was defined as a need for transferred water. The total area of presently irrigated land would require about 537,620 acre-feet of stored or transferred water for a full supply in an 80 percent chance year if used at present efficiencies.

Other water shortages

Probably the second most important kind of water shortage in the basin is for livestock water on rangelands. This problem is related to proper grazing management. Unherded cattle and sheep remain fairly close to water. Good grazing management requires that suitable livestock water facilities are well distributed throughout the range. About two-thirds of the rangeland in the basin needs to have more of these facilities.

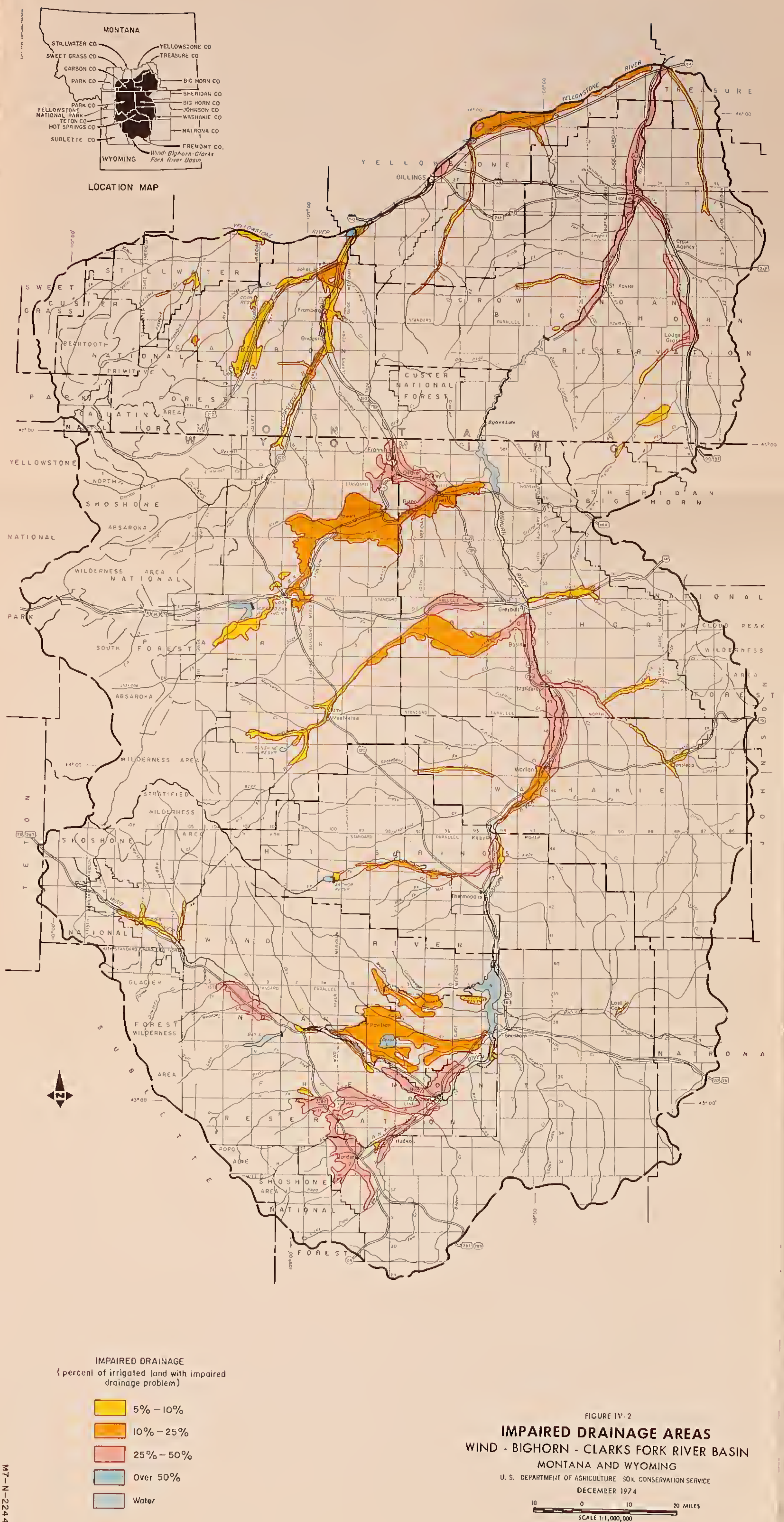


FIGURE IV-2

IMPAIRED DRAINAGE AREAS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

SCALE 1:1,000,000

M7-N-22441N

In order for open drainage ditches to function properly, they must receive annual maintenance to remove debris and sloughed-in banks and to be kept free from excessive vegetative growth. Two Leggins Irrigation Unit.

PLATE 24

Some land with impaired drainage is presently cropland with limited production.

Most of the land described as poorly drained is presently of little use to either agriculture or wildlife.

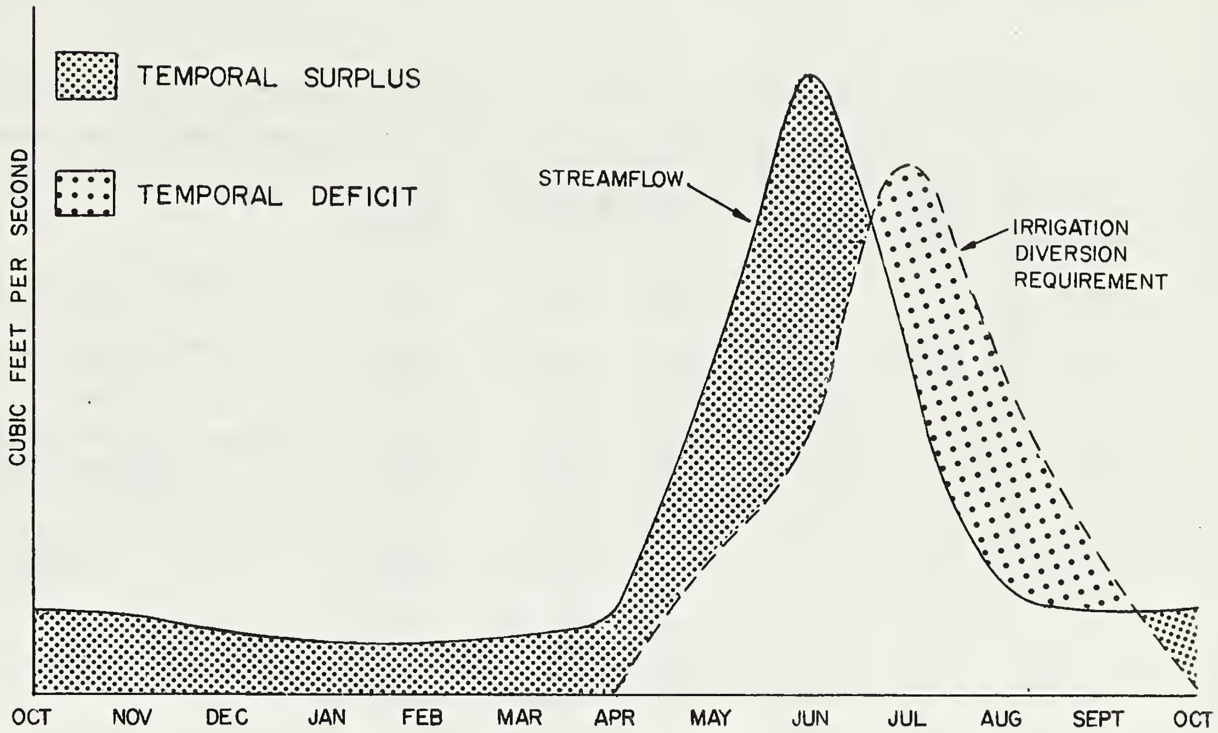


FIGURE IV-3--TYPICAL STREAMFLOW AND IRRIGATION DIVERSION REQUIREMENT CURVES

Table IV-5--Water supply shortages on presently irrigated lands with present efficiencies

Subbasin	Present area of irrigated land	Irrigation diversion requirements 1/	50 percent chance: Present water diversions	50 percent chance: Need for stored or transferred water	50 percent chance: Transfer needs 2/	80 percent chance: Present water diversions	80 percent chance: Need for stored or transferred water	80 percent chance: Transfer needs 2/
	--acres--	-acre-feet--	-acre-feet-			-acre-feet-		
Wind River	195,769	868,490	768,800	99,690	4,050	730,620	137,870	35,940
Bighorn River in Wyoming	329,503	1,747,820	1,604,700	143,120	58,800	1,531,900	215,920	138,610
Bighorn River in Montana	56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
Subtotal for Bighorn River Subbasin	385,957	2,018,240	1,864,980	153,260	64,240	1,787,570	230,670	149,220
Little Bighorn River in Wyoming	2,441	11,890	7,770	4,120	0	7,000	4,890	0
Little Bighorn River in Montana	17,134	99,700	99,700	0	0	99,360	340	340
Subtotal for Little Bighorn River Subbasin	19,575	111,590	107,470	4,120	0	106,360	5,230	340
Clarks Fork River in Wyoming	11,119	61,230	60,230	1,000	0	59,950	1,280	0
Clarks Fork River in Montana	88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980
Subtotal for Clarks Fork River Subbasin	99,747	643,660	563,430	80,230	75,390	480,560	163,100	157,980
Stillwater River in Montana	29,252	175,110	175,110	0	0	175,110	0	0
Yellowstone Minor Drainages in Montana	39,951	253,670	252,920	750	0	252,920	750	0
Total in Wyoming	538,832	2,689,430	2,441,500	247,930	62,850	2,329,470	359,960	174,550
Total in Montana	231,419	1,381,330	1,291,210	90,120	80,830	1,203,670	177,660	168,930
Total for river basin	770,251	4,070,760	3,732,710	338,050	143,680	3,533,140	537,620	343,480

1/ Based on average annual consumptive uses and estimated existing irrigation project efficiencies.

2/ Assuming all undiverted water is storable in the local stream. Otherwise transfer needs are greater than shown here.

Another water shortage problem exists where flows in some smaller streams are too low for good fish production in late summer.

Some of the towns in the basin have facilities and water supplies too small to meet peak demands in July and August and are required to ration water for lawn and garden irrigation during these periods.

PHREATOPHYTES

Phreatophytes are plants that thrive in areas where the water tables are at or near the surface and use large amounts of water when it is available. They generally have low economic value, either because they produce little usable fiber or food products or because of their high cost to harvest. Not including the narrow strips along irrigation and drainage ditches, about 241,600 acres or 378 square miles of land are mapped as having phreatophytes. The predominant types of vegetation are sedges, rushes, greasewood, willows, and cottonwood trees. They may be considered a problem because they use about 600,800 acre-feet of water per year that might otherwise be available to improve streamflows for higher valued crops or for other purposes.

There is no notable program for phreatophyte control in the basin. Projects have been proposed to drain some phreatophyte-covered areas and convert them to agriculture. Some control projects at the local level are associated with canal and irrigation system renovation and on-farm land clearing and leveling.

Because phreatophytes have low economic value does not mean they are unimportant. Some species of phreatophytes are important habitat for big game, upland game, and small game, as well as for many other wild animals and livestock. When located on the banks of streams, they provide food, cover, and shade for fish and other aquatic species. Areas with cottonwood trees are particularly important as calving areas for range cattle, habitat for deer, and as attractive recreation areas. The Wyoming Game and Fish Commission has developed two areas of heavy phreatophyte concentration as wildlife management units. Any proposal to eliminate significantly large areas of phreatophytes must consider the total value of these areas and compare beneficial and adverse effects with those of alternative approaches.

POLLUTION

To pollute is to make something impure or unclean. The concern about pollution relates to the basic natural resources required by all living organisms--air, water, land, and food. The paradox is that every living thing pollutes these basic resources to some degree. The basic resources also pollute each other as they interact through the movement of soil, air, and water. The result is that nothing in nature is really pure, and the pollution problem is a matter of degree.

In this report we will discuss the pollution problem primarily as it relates to the water resource. Every water use has a minimum water quality requirement. Whenever the source of water fails to meet this requirement, this use is lost or made more expensive by treatment costs. Fortunately, the water quality of the surface waters of the basin can generally be described as high enough for irrigation, recreation, livestock, wildlife, and industrial uses. Most other uses require minimum treatment to remove turbidity and biological factors.

The main pollution problems are sediments and dissolved salts. The Wind River at Dubois has an average of only 105 milligrams per liter (mg/l) of dissolved salts. By the time this water leaves the basin, the concentration of dissolved salts reaches about 700 mg/l. Concentrations this high begin to have some adverse effects for irrigation, livestock, and wildlife uses. There are some small, low elevation, ephemeral streams in which dissolved salts exceed an average of 1,200 mg/l. Briny waters from some oil fields contribute to this problem.

Silvertip Creek is being polluted from the Elk Basin oil field to the extent that the Montana Animal Health Director recommends that cattle be kept from drinking the oil-laden water. The industrial practice is to provide primary oil separation treatment to these waters before releasing them. Much of this water is still used for irrigation and livestock.

Sediments in the water are particularly evident during high flows. The sediment yield to Boysen Reservoir has been serious enough to be the object of a special study.[1/] The opening of a new portion of the Riverton Reclamation Project probably accelerated the erosion of Fivemile Creek. Much of this problem has been stabilized to levels about like those of other relatively undisturbed areas of the basin. Sediment pollution damages were discussed earlier in this chapter.

Municipal and industrial waste waters in the basin generally lend themselves to treatment stabilization or full retention. A few small communities are still in need of adequate sewage treatment plants.

Mine acid pollution has been identified by the Forest Service in the headwaters of the Stillwater River and in Fisher Creek tributary of Clarks Fork River near Cooke City. Mine workings and tailings near Nye are a source of sediment and metals during periods of high runoff.

Feedlots are developing and expanding in the basin and are expected to increase in the future. Runoff and waste waters from feedlots need to be treated to prevent increased stream pollution.

Pollution from recreational facilities is generally low. This is credited to servicing of these facilities by the responsible agencies. Some activities of recreationists create pollution problems, especially

---

1/ Sedimentation and delta formation in Boysen Reservoir, Wyoming, USDI, Bureau of Reclamation, October 1960.

as they promote erosion and sedimentation. Some wilderness areas have been affected by riding stock and trailriders. Some health and sanitation problems exist in these areas.

RANGE AND FOREST FIRES

Range and forest fires occur often, and there is a cyclic pattern in the occurrence of large fires. On the average about 333 fires burn over 17,900 acres in the basin each year. The majority of the fires are small and result in relatively minor damages. Large, disastrous fires occur periodically and cause significant economic and environmental damage.

Some major problems which could contribute to disastrous fires are: (1) a heavy accumulation of logging debris and slash on some areas, (2) extensive stands of overmature timber, (3) large areas of insect damaged timber, and (4) dense overcrowded stagnated stands of timber. Other factors contributing to fire problems include heavy build-up of fuel on areas long protected from fire, increased use by hunters, recreationists, and other users of forest resources, and a lack of organized fire protection for private land in some counties.

OTHER FOREST-RELATED PROBLEMS

Insect and disease damages are high on most forest types. It is estimated that up to 50 percent of the gross annual timber growth may be lost to insects and diseases. Mountain pine beetle, Douglas fir beetle, and spruce budworm are endemic in nearly all stands. Major diseases causing loss are dwarf mistletoe, commandra rust, and butt and heart rots.

Timber losses due to insects, disease, animal, and mechanical damage are significant on large areas of overmature forest. Overstory suppression is responsible for reduced growth rates on thousands of acres of established seedlings and saplings. In addition, overstocked, stagnated stands of small size timber occupy thousands of acres but produce little usable wood.

Another major problem is the lack of adequate regeneration resulting from livestock and wildlife damage, insufficient summer moisture, the large size of some non-stocked areas, and erosion of the thin, young soil. These problems are particularly severe on the Paint Creek and Pat O'Hara Creek watersheds.

Overgrazing, poor stocking of vegetation, and concentrations of noxious and poisonous plants damage rangelands and prevent full production and use of grazing resources on national forest lands.

Full use of forest recreation resources is inhibited by the lack of developed facilities and sites, or inadequate road network, insufficient trails development, uneven geographic distribution of lakes, reservoirs, and other water developments.

While there is access across some private lands to public lands, public access is blocked in many areas by private landowners who refuse to sell or grant crossings or rights-of-way to public lands. This causes overcrowding and facility problems at some existing access points and uneven recreational use of the public lands.

FISH AND WILDLIFE HABITAT PROBLEMS

Historically, loss and degradation of habitat is the primary problem related to fish and wildlife. This loss and degradation has been compensated for in part by intensive management such as winter feeding of elk in Wyoming, acquisition of land for fish and wildlife management purposes as well as for access, and construction of nesting facilities for waterfowl.

Big game

Winter habitat is the main limiting factor for big game. Decreases in winter habitat have resulted from development of minerals, highways, agriculture, recreation, and other increased human activities. Specific problem areas are described below:

a. Open pit mining and increased mineral exploration have decreased some winter habitat in the Gas Hills Mining District southeast of Lander.

b. Lack of watering facilities in the "badlands" in the central portion of the Bighorn Basin limits wildlife use of these areas.

c. Fencing throughout the basin somewhat restricts migration and distribution of big game. Overgrazing by livestock in some areas limits food for elk and deer both in summer and winter.

d. Artificial reduction of sagebrush and willow in large blocks has reduced some winter habitat for moose, deer, and antelope. The effects of big sagebrush management in any location should be carefully evaluated before being applied.

e. Moose habitat in the basin is very limited and should be carefully evaluated before developing any large reservoirs.

f. Increasing numbers of people using motorized vehicles during all seasons of the year have increased pressure on big game in some critical areas such as in the Big Horn Mountains near Shell Creek and in the Wind River Mountains near Union Pass.

Upland and small game

Intensive agriculture has affected upland and small game animals more than any other species of wildlife. A change in agricultural practices can benefit some species while adversely affecting others.

For example, cropped areas improve habitat for pheasant, quail, and rabbits, but drastically decrease habitat for sage grouse. However, some agricultural practices decrease habitat for all wildlife on agricultural lands. Lining ditches with concrete, clean farming, use of pesticides, and grazing and clearing windbreaks are examples of such practices. Sage grouse habitat is sometimes reduced because of sagebrush control and mining operations. Lack of watering facilities also affects upland and small game distribution.

Waterfowl

Waterfowl habitat is limited in the basin by lack of nesting and feeding areas.

Furbearers

Furbearers generally require heavy cover along streams. Much of this habitat has been removed through agricultural practices, road building, and other activities.

IMPAIRMENT OF NATURAL BEAUTY

Problems related to visual resource of the basin do exist. Litter seems to be a problem wherever there is human activity. Gullies and other erosion scars in otherwise well vegetated areas offend the viewer. Aesthetic values are often damaged by alteration of the natural landscape related to timber harvest, mining, transmission lines, and roads. Oil spills, waste discharges, and sediment in streams reduce the visual and olfactory quality of some landscape and water areas. Junked and abandoned cars are scattered about and are especially evident near small towns.

ECONOMIC PROBLEMS

One of the most important economic problems in the basin is the unemployment and underemployment of Indians. Part of the problem is related to land use on the reservations. About 23 percent of the land within reservation boundaries is no longer owned by the Indians. Some land went into roads, railroads, and reservoirs; but most was bought by white ranchers and farmers. Much of the best cropland and ranchland is now in non-Indian ownership, leaving more marginal land to the Indians.

A higher percentage of the total potentially irrigable land has been developed off the reservation than has been developed on the reservation. This is partially explained by the difficulties in administration of multiple ownership of small tracts of land, limited Indian development capital, early sale of good lands to whites, and differences in economic pressures confronting Indians and non-Indians. For example, division of property rights among the heirs has progressed to the point that many tracts of land now have over 100 fractional owners. Administration or legal clearance for the development of such lands is almost impossible under

present statutes. There are also some institutional and social barriers to economic development which are not discussed here, since they are beyond the scope or intent of this investigation.

Underemployment and limited specialized services are problems for nearly all of the residents of the basin. These problems, as well as the limited oppotunities for employment in the basin, are probably the reason for the high out-migration rate discussed in Chapter III.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

This chapter describes needs for protection, management, and development of water and land resources in the basin to solve existing problems and provide for future needs for these resources.

NEEDS FOR WATERSHED PROTECTION AND MANAGEMENT

The improved use of conservation practices, both in management and structural treatment measures, is needed to increase the productivity of the land, aid in the prevention of floods, reduce erosion, improve water quality, stabilize stream channels, and sustain streamflows.

State and private lands

There are about 9,176,220 acres [1/] of private, state, and Indian trust lands in the basin. Table V-1 lists major categories of needs for conservation practices on these lands. The first line in this table estimates areas where the present level of conservation treatment is considered adequate. This means that, where feasible, the needed structural measures are installed, management and cultural practices meet the needs of the land, and water is efficiently used. There is still a need to continue the existing level of management and to maintain structures or replace them as they wear out.

Irrigated cropland

There are about 770,250 acres of irrigated cropland in the basin. This is about 8 percent of the nonfederal land. About 52 percent of the irrigated land needs improvement in water delivery or drainage systems, water management, and cultural management.[2/] About 23 percent of this land has adequate systems, but still needs improved water management and cultural management. About 10 percent has adequate systems and water management but still needs improved cultural management.

Nonirrigated cropland

About 4 percent of the nonfederal land in the basin is nonirrigated cropland. Nearly all of this is in Montana. About 59 percent of this land needs improved cultural management.

Range and dry pastureland

About 80 percent of the private and state land in the basin is grass or brush rangeland. About 66 percent of this land needs improved conservation

---

1/ Water areas and nonagricultural uses totaling about 161,550 acres not included.

2/ Cultural management includes, but is not restricted or limited to, such practices as rotation cropping, minimum tillage, stubble mulching, contour furrowing, rotation grazing, etc.

Table V-1--Conservation treatment needs on state and private lands with present land use [1/]

Treatment category	Irrigated cropland	Non-irrigated cropland	Range and dry pastureland 2/	Non-federal forest	Other agricultural	Total
	---acres---					
Present treatment adequate or treatment infeasible	118,510	139,610	2,499,080	490,240	61,900	3,309,340
Cropland practices						
Irrigation and/or drainage systems	399,420					399,420
Water and cultural management	174,560					174,560
Cultural management only	77,760	209,020				286,780
Range and dry pasture practices						
Proper grazing use and planned grazing systems only			3,715,410			3,715,410
Accelerated range improvement						
Brush and weed control			1,052,630			1,052,630
Reseeding			8,480			8,480
Range renovation			36,420			36,420
Forest practices				152,030		152,030
Other land practices					41,150	41,150
Totals	770,250	348,630	7,312,020	642,270	103,050	9,176,220

Source: Conservation Needs Inventory, 1970, and U.S. Forest Service inventories

1/ Water areas and state and private lands in non-agricultural uses are not included.

2/ All irrigated pasture is included in irrigated cropland.

practices. The primary need is for improved grazing systems and management. About 14 percent of the rangeland also needs brush and weed control. Reseeding and renovation practices are needed on about 1 percent. If these lands are properly vegetated, there will be little need for structures for erosion control, and productivity will increase.

The need for improved grazing practices is closely related to the need for additional stockwater facilities described later in this chapter.

Nonfederal forest land

About 7 percent of the state and private lands are forest lands. A large portion is on the two Indian reservations and is expected to be managed to remain in a natural or roadless state. About 24 percent of all nonfederal forest lands need improved timber and grazing management practices.

As recreation use increases, there will be a need to increase fire prevention and protection measures, improve roads and trails, provide adequate sewage and garbage facilities, prevent overuse of recreation sites, and control off-road vehicular travel. Mining operations must be controlled to minimize damage to aesthetic values and prevent erosion. There is also a need to rehabilitate abadoned mined areas.

Other agricultural lands

These are farmsteads, lanes, ditches, and the like. About two-thirds of these lands need some conservation practice, primarily revegetation.

Federal forest and rangeland

Table V-2 lists forest and rangeland development needs in the basin, and specific items are discussed below. Projections of economic activity for the nation, region, and basin show a need to increase timber production. In order to meet expected demands the supply of timber available for harvesting needs to be increased 12 percent in 1980, 31 percent in 2000, and 39 percent in 2020.

Planting or seeding is needed to reforest or regenerate about 8,800 acres of forest land. This will reduce accelerated erosion and sediment production, improve hydrologic conditions, and contribute to long-range satisfaction of timber needs.

About 127,800 acres of forest stands need to be harvested and regenerated or given salvage and sanitation cuts. This will solve problems of decadence and excessive losses from insects and diseases on these areas. Timber supplies can be significantly increased, and grazing and wildlife resources can be improved.

Thinning, weeding, release cutting, pruning, and other cultural treatments are needed to reduce fuel accumulations, improve growth, and combat insects and diseases on 196,600 acres.

Table V-2--Federal forest and rangeland development needs, Wind-Bighorn-Clarks Fork River Basin, Wyoming and Montana

Development need	Unit	National forest	Public domain	Development need	Unit	National forest	Public domain
Range revegetation Plant control, type conversion	acres	36,600	37,300 1/	Fence key wildlife areas	miles	60	N/A
Range distribution trails	miles	190	350 1/	Trail, construction, and improvement	miles	1,840	N/A
Range fences	miles	695	1,000 1/	Road construction and improvement	miles	1,910	N/A
Range water developments	each	363	2,010 1/	Roadside observation sites	each	48	N/A
Timber management:				Erosion control for:			
Planting or seeding	acres	6,778	2,000 1/	Gullies	miles	125	N/A
				Sheet erosion	acres	4,100	N/A
Insect control	acres	51,600	5,000 1/	Abandoned roads and trails	miles	270	N/A
Disease control	acres	140,000	0 1/	Streambank stabilization	miles	30	N/A
Release, harvest, thin and weed	acres	127,800	0 1/	Mining control and restoration	acres	85	N/A
Fishing stream improvement	miles	820	N/A	Snowpack management, alpine	miles	65	N/A
Fishing lake improvement	acres	4,750	N/A	Recreation site improvement	acres	1,163	N/A
Wildlife habitat management	acres	11,700	N/A				

1/ Treatment planned - total needs are not known.

Range seeding, proper herding and distribution, control of noxious and poisonous plants, stockwater developments, and range fencing are needed to improve forage and meet demands for forest land grazing. Type conversion, plant control, and revegetation are needed on about 73,900 acres. About 1,695 miles of fencing to control grazing, 2,373 stock reservoirs, and 540 miles of stock distribution trails are needed.

There is a need for restoration and habitat improvement on 820 miles of streams and 4,750 acres of lakes on national forest land. About 30 miles of streams need treatment to stabilize banks and reduce sediment loads.

Management needs for terrestrial wildlife habitat include wildlife openings and food patches, thinning of dense, stagnated timber stands, openings and trailways in timber, and cover strips in cleared forest areas. On national forest land about 11,700 acres of wildlife habitat restoration and improvement and 60 miles of fencing are needed. Special management and protection is needed to sustain serveral rare and endangered species.

Fire prevention and control measures are needed to reduce the number, size, and intensity of range and forest fires. Some of these needs are reduction of fuel and logging debris, salvage of insect damaged stands, improved fire detection, additional fire weather stations, intensification of aerial fire control, prescribed burning where beneficial, increased study of fire control by weather modification, hazard reduction along roads and trails, and improved coordination between suppression agencies.

Roads, trails, mines and excavations, overgrazed areas, and areas damaged by off-road travel need erosion control measures, revegetation and hydrologic improvement. On national forest land sheet erosion control is needed on 4,100 acres, 125 miles of gullies need control, 270 miles of eroding roads and trails need rehabilitation, and 85 acres of eroding mine areas need treatment.

There is a need for additional development of recreation sites to alleviate seasonal overuse and deterioration of sites and to satisfy projected recreation demands.

An adequate system of roads and trails is needed to develop, manage, and protect forest resources. Construction and reconstruction is needed on about 1,910 miles of forest roads. Included is a network of low-speed high standard scenic roads with more than 48 scenic observation sites. About 1,840 miles of recreation trails are needed for backpack hiking, horseback riding, trail bike and snowmobile use, and walking for pleasure.

NEEDS FOR FLOOD PREVENTION AND SEDIMENT CONTROL

Floods are a problem in the basin though damages in the past have been limited because of sparse population and intelligent location of most

residences out of the floodplains. Future damages will be greater unless floods are reduced and development in floodplains is severely restricted. The most urgent needs for additional floodwater and sediment control are for communities and rural residences on Little Popo Agie River, Nowood River, Lodge Grass Creek, Blue Creek, Little Bighorn River, Pryor Creek, and Stillwater River. Protection for agriculture is needed on Crow Creek, Beaver Creek, Badwater Creek, Little Popo Agie River, Nowood River, Greybull River, Shell Creek, Shoshone River, Lodge Grass Creek, Blue Creek, and Little Bighorn River.

The primary need is to prevent the construction of buildings or residences within the 100 year floodplains. There is also a need to develop flood prevention storage in upstream reservoirs or levees to protect existing developments and agricultural land. Some existing buildings need to be removed from the floodplains of Blue Creek, Pryor Creek, Little Bighorn River, Rock Creek, and the Stillwater River and its tributaries. These buildings not only receive frequent damage but endanger other properties by reducing channel capacities.

GULLY AND STREAMBANK STABILIZATION NEEDS

The watersheds inventory in the 1970 conservation needs inventory lists about 95,000 acres with significant erosion damage in this basin. Most of this area is associated with unstable channels. Structural practices needed to reduce this damage include diversions, terraces, grade stabilization structures, debris basins, channel stabilization, streambank protection, clearing and snagging, improved diversion dams, drop structures for irrigation return flows, and flood retarding dams. Streambank revegetation and grassed waterways and other vegetation related practices are also needed.

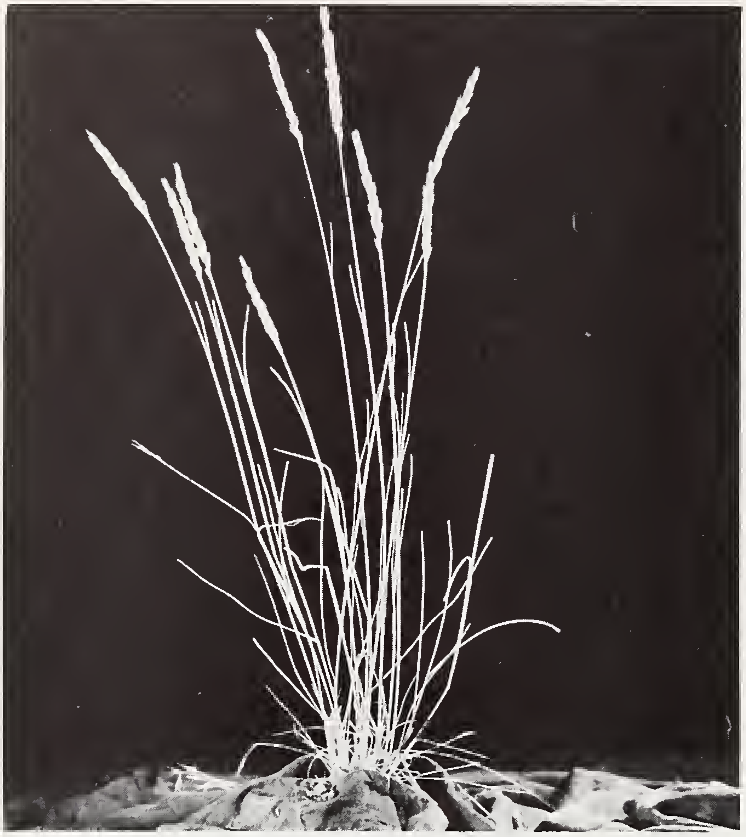
When applied, conservation practices listed in table V-1 which reduce sheet and rill erosion will also help reduce gully and streambank erosion. They reduce surface runoff rates, thus reducing erosive energy in the basin's streams. Artificial as well as natural channels need to be stabilized. One of the most critical of these is the Enterprise Ditch near Lander.

DRAINAGE IMPROVEMENT NEEDS

There are about 145,900 acres of poorly drained croplands in the basin. The high water table problems need to be reduced through improved irrigation water management, lining of canals to reduce seepage, and the installation of open and closed drains if this land is to be used efficiently. Drainage of these lands will allow increased grain production and generally benefit waterfowl and upland game. Many existing drains need rehabilitation or replacement. Additional drainage will be needed if new lands are irrigated. For the most part, these lands should not be confused with wetlands which are important to wildlife.

Among the important conservation needs in the basin are improved irrigation water delivery structures, tailwater recovery structures, and improved water management on the fields.

PLATE 26



Rhizomatous wheatgrasses are native to rangelands in the basin. Good healthy grasses are food for livestock and wildlife and cover for birds and other small animals. Grasses improve soil structure, prevent soil erosion, and increase soil moisture by reducing losses of snow and rainfall.

About 80 percent of the private and state land in the basin is rangeland. The primary range conservation need is improved grazing systems and management.

PLATE 27

About 14 percent of the rangeland needs brush management and weed control.

Grass for livestock is not enough. Wildlife habitat needs must be properly considered.

A well-balanced plant community is needed to provide for a variety of life.

There wasn't enough water to provide a second irrigation. Both supplemental water supplies and improved irrigation efficiencies are needed.

Only about one-third of the livestock water supplies needed to improve range use have been developed.

NEEDS FOR IRRIGATION WATER

Agriculture is and probably will continue to be one of the most important sectors of the basin's economy. Some of the economic and social problems discussed earlier, such as underemployment, low per capita income, and extensive out-migration are related to agriculture. These problems may be alleviated by increasing farm incomes and agricultural crop production.

Currently, about two-thirds of the value of agricultural production comes from irrigated lands. Where the water available to these lands is less than its potential consumptive use, an increase of water supply will increase production.

Better efficiencies can provide some of this water without increasing diversions from the supply streams. Improved irrigation systems and improved management of irrigation water are needed to reduce tailwater, deep percolation, evaporation, and improve the uniformity of water distribution on the field.

Increased efficiency has the least effect on production (and on downstream annual water supplies) on the smaller stream where water supplies are shortest and where present field irrigation efficiencies appear to be the lowest. This is because the main limitation is a severe shortage of water in the supply streams during the peak growing months of July and August. These areas need additional late season water supplies from storage reservoirs, wells, or intrabasin transfers of water if production is to be significantly increased. Only when these supplemental supplies are provided will the benefits exceed the costs of providing improved systems and management in these areas.

There are about 770,250 acres of irrigated land in the basin. About 329,000 of these are in watersheds which are short of a full and reliable water supply. These watersheds will need about 537,620 acre-feet of supplemental water annually in dry years. See table IV-5 for a breakdown of these shortages by subbasins.

As shown in table III-10, irrigated land is expected to increase from 770,250 acres at present to 857,100 acres by 2020. This is an increase of 86,850 acres. This new land use will require about 180,000 acre-feet of water per year for consumptive use requirements. If this water is used at an average 50 percent overall efficiency, this will be a 360,000 acre-feet water requirement.

NEEDS FOR RURAL, DOMESTIC, AND LIVESTOCK WATER

The primary need for livestock water is related to the need for improved range management. As a rule of thumb there should be a livestock watering facility in each square mile of rangeland to promote even distribution of grazing pressure. Surface water in streams, ponds, and springs

is not sufficiently distributed to provide the needed supply. Only about one-third of such needed supplies has been developed in the basin. To achieve the proper range improvement, more wells, spring developments, drift fences, and ponds need to be developed.

Potable water for human consumption on farms and ranches is supplied largely by wells. Some of this supply is poor in quality because of high salts content. Residents between Yellowtail Dam and Hardin, Montana, have been exploring the feasibility of a water treatment plant and pipeline system to serve their farms. The residents near Fromberg also need improved water supplies.

NEEDS FOR MUNICIPAL AND INDUSTRIAL WATER

At present there is generally an adequate water supply for the towns in the basin and for existing industry. Some towns have a need to enlarge and improve their water supply systems to replace old systems or to serve population expansion.

Water needs of new industry, developing outside the basin, will likely have a major impact on future water development in the basin. Coal deposits in northeastern Wyoming and eastern Montana are expected to become a major energy source in the near future. The development of energy from coal in modern plants requires large amounts of water. The Bighorn River is the nearest source of large quantities of available water. Industrial companies have already indicated an interest by purchasing options from the Bureau of Reclamation to use this water when a project is developed to transport the water to the coal fields.

RECREATION NEEDS

Recreation is an important use of water and related land resources in the basin and the surrounding area. Yellowstone and Grand Teton National Parks, Yellowtail Dam and Big Horn Canyon National Recreation Area, Custer Battlefield National Monument, Reno-Benteen Battlefield Memorial, and several Wilderness and Primitive Areas are located in or adjacent to the basin. Many tourists and recreationists travel to or through the basin while enroute to these well-known attractions. A major part of the recreation activity occurs on public lands.

In the Wyoming portion of the basin there are four state parks covering an area of 55,500 acres of land and water. Hot Springs State Park near Thermopolis contains one of the world's largest mineral springs and one of the few remaining buffalo herds. Sinks Canyon State Park, Boysen State Park near Shoshoni, and Buffalo Bill State Park near Cody surround large reservoirs, each containing several thousand surface acres. Chief Plenty Coups Memorial State Monument is in Montana, and Pompeys Pillar is a registered national historic landmark. Dude ranches, resorts, historic places, and municipal parks also provide recreation opportunities.

Recreation needs in the basin are a function of both local and national forces. However, the latter will become increasingly more important in the future. Along with increases in population, vacation and leisure time, and per capita income, there will be associated increases in recreational pursuits. The Wind-Bighorn-Clarks Fork Basin will have to absorb some of this pressure.

Total recreational use is projected to increase from 6,512,200 visitor days in 1970 to 13,489,100 visitor days in 2020, an increase of 107 percent. This increase is a function of increases in both resident and nonresident populations. Projections of use may be low because additional population increases associated with coal strip mining to the east of the basin were not considered.

In this report, all levels of recreation activity are expressed in visitor days where one visitor day equals 12 hours of recreation participation. This measure does not necessarily indicate the number of times a particular activity is enjoyed; for example, it is assumed that one visitor day of picnicking represents six persons having one 2-hour picnic or one person having four 3-hour picnics. However, one picnic table is occupied for each picnic, and a picnic table might be used only once (probably 2 to 4 hours) during a day and perhaps no more than twice. Each visitor day may represent more than one recreational experience. More than one-half of the total annual use occurs during peak periods associated with weekends and holidays.

There is a demand for more and better outdoor recreational facilities in the basin even though the reported capacity of existing facilities exceeds the reported use. Camping facilities in the basin are not now adequate for peak period demands although some campgrounds are not completely filled even during peak periods. The need is for additional and improved facilities in high use locations.

Private lands near public lands may provide the best opportunity to develop additional recreation facilities since private businesses are permitted to determine economic feasibility of development. This is likely to be the only way in which additional recreational facilities can be provided, since public construction funds for this purpose are limited. Public monies might be used to provide better access to public lands and improved public information. Facilities provided through the investment of nonpublic funds will more closely approximate the demand for recreation, since private entrepreneurs tend to develop resources only to the extent that the recreationists will pay for its use. In addition, emphasizing facility development on private lands while investing public recreational funds in supporting services will minimize competition between these sectors. Other factors which may affect recreational use on private lands include national park policies to reduce and eventually eliminate camping facilities and the further restriction of vehicular travel to designated roads and trails on public domain and national forest lands.

As the use and development of recreation areas increase, there will be a greater need to control the location and distribution of facilities and recreation demand. This may require city and county zoning laws, additional information concerning use-density relationships, price incentives to shift the recreation demand more to midweek, and improved design and maintenance of recreation facilities.

FISH AND WILDLIFE NEEDS

The projected needs for development of recreation facilities also point up the growing demand for fishing. Storage of water in reservoirs to maintain or augment flows in trout streams or to provide permanent storage for fish and wildlife should be considered wherever financial sponsors can be found to pay for the nonfederal share of costs for these purposes. Benefits to fish and wildlife from erosion and sediment reduction by land treatment and structural practices need to be encouraged and publicized.

The demand for hunting opportunities for both residents and non-residents is expected to increase. Population increases and changes in per capita income will influence the amount of hunting opportunities desired. The capacity to increase the supply of game species is dependent upon the quality and quantity of habitat available. Acquisition and management of additional habitat will be needed if game populations are to be maintained or expanded. Improved habitat for game animals should provide an increase in population of other desirable species as well.

When projects are developed, care should be taken so that habitat areas near the project site are not seriously degraded. Interagency cooperation leads to better use of available fish and wildlife resources and provides for increased benefits. Special emphasis needs to be placed on developing wildlife habitat near population centers and along tourist routes.

NEEDS FOR WATER QUALITY CONTROL

At 620 to 695 milligrams per liter, the dissolved solids content of the water in the Bighorn River is approaching the recommended upper limit of domestic and livestock water use. There is a need to pursue programs which will prevent any further degradation of water quality. Water quality needs to be protected by treating feedlot wastes, reducing erosion, and other similar actions. Increased recreational use will require more facilities and better management to control pollution from human and animal wastes. Increased use of fertilizers wll increase the need to reduce surface runoff from irrigated areas. Accelerated enforcement of water quality laws will be needed as the potential for pollution increases.

NEEDS TO PROTECT NATURAL BEAUTY

There is a growing need to provide for the aesthetic as well as the economic and utility needs of water and land resource development projects. These needs include reclamation of strip-mined areas, regeneration of timber harvest areas, roadside plantings, and design of water storage and diversion structures to complement the natural surroundings. The need is not only to develop an awareness for the quality of visual resources, but also to utilize the skills of landscape architects, ecologists, and engineers in designing projects, related structures, and other land resource development projects to optimize the combination of outputs.

RURAL POWER SUPPLY NEEDS

Electricity to rural areas is supplied primarily by rural electric cooperatives. New power supplies and transmission facilities will be needed, as demands for power are expected to double or triple by the year 2020. Many of the new hookups will be rural nonfarm residences, summer homes, and small industries.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Many state and federal programs and projects provide technical services and financial assistance for resource management and development needs in the basin. The public should be well informed of the services and assistance available and how they can be utilized. This chapter lists some administering agencies and briefly describes their current programs.

USDA PROJECTS AND PROGRAMS

Soil Conservation Service

The Soil Conservation Service (SCS) assists conservation districts in giving technical assistance to individuals, groups, organizations, towns, cities, counties, and state governments in reducing costly waste of land and water resources and in using them according to their capabilities. This is accomplished through unified planning that combines all the technologies, considers all the resources, and recognizes the human interests that apply to each area of land and water use. The major SCS programs available to residents of the basin are described below:

Assistance to landowners

The SCS has a basic continuing program of providing technical assistance in the conservation of land, water, and related resources as requested by landowners and entities of state and local government which have planning authority. Conservation districts provide local direction, leadership, and coordination of this program. Conservation district programs are available for the entire basin. The services available include assistance in farm and ranch planning, field services for installation of conservation practices, soil surveys, plant materials improvements, snow surveys, water supply forecasts, technical assistance for agricultural water management, and other such services.

Under the Great Plains Program, available in some northern portions of the basin, the SCS also provides cost-sharing under contracts for water and land conservation measures for cooperating landowners. Part of a Great Plains agreement includes long-range continued planning for each farm or ranch.

Conservation practices installed in the basin with SCS assistance include irrigation ditch improvements, land leveling, irrigation management systems, stubble mulching, stripcropping, chiseling and subsoiling, stock ponds, spring and well developments, fish ponds, grazing management systems, fencing, brush management, and wildlife cover plantings. Advice is provided for erosion control connected with new construction of homes and highways. Technical assistance is provided for rural sewage disposal and pollution prevention measures for homes and feedlots. Soils, hydrological, and geological interpretation assistance are provided for rural town sewage disposal systems.

Watershed protection and flood prevention projects

The SCS provides technical and cost-sharing assistance in project type undertakings to qualified local sponsoring organizations in planning, designing, and installing land treatment measures and structural works of improvement to reduce floodwater, erosion, and sediment damages and to promote other water and related land management and development practices. Applications for assistance are submitted to the Secretary of Agriculture through the Governor or his designated state agencies and the State Conservationists of the SCS.

There is one existing watershed project in the basin. This is the Candy Jack Watershed Flood Protection Project in and near the town of Thermopolis. About 4,000 feet of large diameter pipe have been installed to protect about 100 homes and 10 businesses on about 400 acres from frequent flooding.

There is one active watershed application in the basin. The application for Two Leggins Canal in Montana is awaiting preliminary investigation. There are several inactive applications for watershed projects in the basin.

Resource conservation and development projects

The SCS is responsible for coordination of U.S. Department of Agriculture RC&D activities and provides technical and financial assistance to locally sponsored RC&D projects. The objective is to expand socio-economic opportunities for the people of an area by assisting them in developing and carrying out plans of action for the orderly conservation, improvement, development, and wise use of their natural resources.

Applications for projects are submitted to the Secretary of Agriculture through the Governor or his authorized agency and the State Conservationist of the SCS. When a project is authorized for planning assistance, a coordinator is appointed who assists local sponsors in developing a plan. This takes from 6 months to a year or more. Most projects have citizen and advisory committees for agriculture, forestry, water resources, business and industry, transportation, health, education, recreation and wildlife, and community facilities. Policies and priorities are set by a steering committee or executive council composed of the representatives from the sponsoring local units of government. The project then becomes eligible for technical and financial assistance in project measures.

The Bighorn Basin RC&D Project for Big Horn, Fremont, Hot Springs, Park, and Washakie Counties (which include most of the Wyoming portion of this river basin) is operational. The Beartooth Resource Conservation and Development Project serves all of Carbon and Stillwater Counties in Montana.

<u>U.S. Forest Service</u>

The U.S. Forest Service provides technical assistance to state and private owners through cooperative agreements with the State Forester.

It also administers national forest lands under the multiple use concept to provide forest products, recreation, forage, and watershed protection. Specific programs are as follows:

Cooperative state-federal forestry programs

The Forest Service and the State Foresters cooperate in a number of programs in the basin designed to promote better management and protection of state and private forest land. The cooperative forestry programs are administered through the State Foresters of Wyoming and Montana.

Foresters assist each county or state district in making wildfire plans, obtaining equipment, organizing and training fire suppression forces. Suppression of fires is performed primarily by the counties, and technical assistance is furnished by the State Forester. Some progress is being made in providing adequate fire protection for the private, state, and other nonfederal land in the basin under the cooperative protection program. Only about half of the private land in the Wyoming portion of the basin is covered by cooperative fire control agreements.

Through the cooperative forest management program, the federal government shares with the states the cost of assisting private woodland owners, loggers, and processors of forest products. The program provides technical guidance in the multiple-use management of woodland resources.

The cooperative forest management program is growing, gaining support, and is needed to improve the marketing and utilization of forest products and increase the productivity of private forested lands.

The major program utilized in the basin is cooperative distribution of planting stock under provisions of section IV of the Clarke-McNary Act of 1924. Under this program, private landowners may obtain tree seedlings from their State Forest Service in Montana and from the University of Wyoming through county agents in Wyoming for windbreaks, shelterbelts, and forest plantings.

Authority to enter into cooperative agreement with the states is provided by the Federal Pest Control Act of 1947. The State Forester is responsible for detection, evaluation, and control of insect and disease problems on private and state forest land.

National forest development and multiple use programs (Early Action)

National forest watershed management includes coordination of all other forest resource uses to maintain and improve watershed conditions. Planned measures benefiting watersheds include range revegetation and type conversion on 14,600 acres, 5 miles of gully control, 388 miles of range fence to protect problem areas and newly established vegetation, and reforestation and afforestation of 5,778 acres (table VI-1). In addition, thinning, releasing, and weeding planned primarily to benefit timber resources can have a secondary effect of increasing water quantity by reducing evapotranspiration.

Table VI-1--Land treatment and structural measures currently planned under existing programs for the national forest lands in the Wind-Bighorn-Clarks Fork River Basin

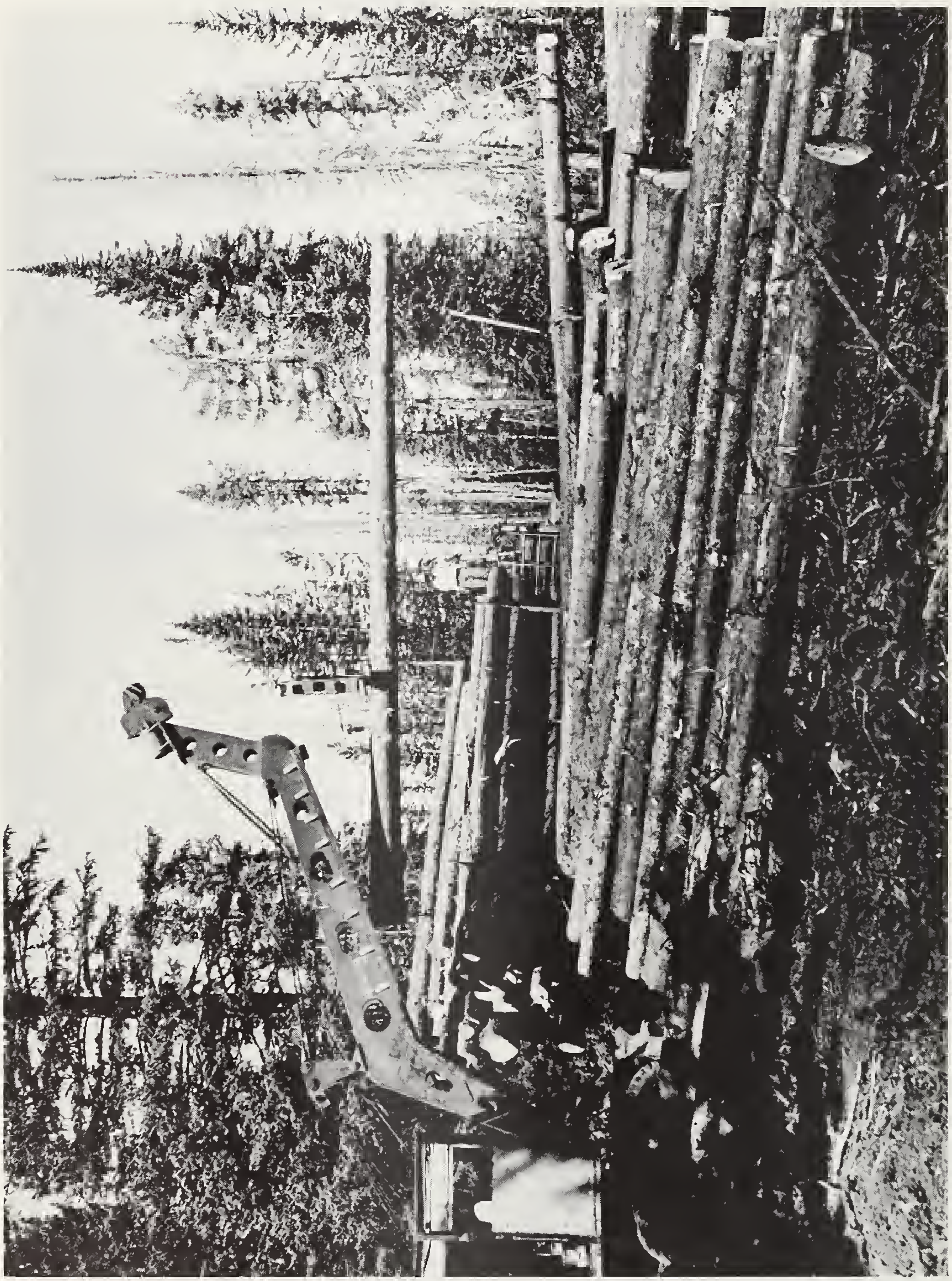
Item	Amount	Unit
Range revegetation - plant control and type conversion	14,600	acres
Range management - stock distribution trails	160	miles
Range management - fencing	388	miles
Range management - stock water developments	261	each
Reforestation and afforestation - planting and seeding	5,778	acres
Timber management - release weeding, thinning, and pruning	23,100	acres
Fish habitat improvement - streams	410	miles
Fish habitat improvement - lakes	1,160	acres
Wildlife habitat management - establish forage plants and release wildlife food plants	30	acres
Wildlife habitat restoration and development - protect key areas by fencing	3	miles
Trail construction and improvement	1,440	miles
Road construction and improvement	1,560	miles
Roadside observation sites	10	each
Road, trail, and stock driveway bridges	51	each
Erosion control - gullies	5	miles

Timber is an important product of the national forests; and, as projections in chapter III indicate, increasing demands are expected in the future. Timber management activities planned under existing programs include up-to-date inventories on all national forest lands, better timber sale preparation and administration, reduction of insect and disease losses, improved utilization of available timber, reduction of fire losses, continued research to improve genetic characteristics of trees, and provide better silvicultural practices (table VI-1). More specific activities include constructing 1,560 miles of roads and 51 bridges; releasing, weeding, thinning, and pruning on 23,100 acres; and reforestation and afforestation on 5,778 acres. Achievement of these planning goals

The SCS assists conservation districts by providing technical assistance to landowners.

A large diameter pipeline now provides flood control for the Candy Jack Watershed.

The Recreation and Tourism Committee meets to help develop the Bighorn Basin RC&D plan.



Timber harvest management is just one of the activities of the U. S. Forest Service.

U.S. FOREST SERVICE PHOTO

in the next 10 to 15 years will have some effect on timber supplies in the 1980-1990 period, but most will come in 2000 to 2020 and beyond.

The development and management activities planned under existing range resource programs are: complete allotment inventories and management plans for all national forest land; revegetation, plant control, and type conversion on 14,600 acres; and construction of 388 miles of range fence, 160 miles of stock distribution trails, and 261 stockwater developments.

Most of the outstanding natural attractions and potential outdoor recreation areas are in the national forests. It is the objective of the Forest Service to develop and manage the recreation resources to meet the demand in terms of kind, quantity, and quality. Current Forest Service policies and programs are adequate to supply projected demand for outdoor recreation sites for most land-based activities through 2000.[1/] Some planned measures are 1,440 miles of trail construction and improvement, 1,560 miles of road construction and improvement mentioned previously, and 10 roadside observation sites, vista points, and scenic turnouts.

Wildlife and fish resources attract many visitors, and this use is expected to increase. The resources are considered adequate to meet current demands in spite of reductions in the amount and quality of habitat. The Forest Service program is designed to enhance wildlife and fishery resources, improve lowered quality, and mitigate losses from development and land use changes.

Measures planned for the next 10 to 15 years include about 400 miles of stream habitat improvement, lake habitat improvement on 1,150 acres, establishment and release of wildlife forage plants on 30 acres, and 3 miles of fencing to protect key wildlife areas. The watershed programs which reduce erosion and sediment will have a favorable effect on fisheries as water quality is improved or maintained.

Fire control within the national forest boundary is the responsibility of the Forest Service. Forest fire control on private and state timber lands is the responsibility of local fire districts in cooperation with the State Forester in Montana and the counties and the State Forester in Wyoming. Range fires on the public domain are controlled by the Bureau of Land Management. Cooperation between agencies occurs where lands of various ownerships are threatened.

Economic Research Service

The Economic Research Service conducts national and regional programs of research, planning and technical consultation, and services pertaining to economic and institutional factors and policies which relate to the use, conservation, development, management, and control of natural resources.

1/ Some of these programs and policies relate to the development of recreational facilities on private lands.

This includes estimating the extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials and resource investment economics, impact of technological and economic change on the utilization of natural resources, resource income distribution and valuation, and the recreational use of resources. The agency also participates in departmental and inter-agency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

Farmers Home Administration

The Farmers Home Administration serves as the lending agency for a wide variety of loan programs ranging from annual production loans through farm purchase loans to watershed project financing. SCS cooperates with FHA by providing the technical planning information to support loan applications for developments that deal with soil and water conservation measures.

Cooperative Extension Service

The Extension Service is a part of the Cooperative Extension Service partnership. Federal, state, and county governments share in financing, planning, and carrying out information and educational programs. The Extension Service acts as the educational agency of the U.S. Department of Agriculture. Extension specialists and county agents cooperate with other agencies to provide local information relating to conservation programs, weed control, crop culture, animal culture, herbicides, pesticide fertilizers, homemaking, and other types of information and assistance.

The Extension Service has the organizational leadership in the Community Rural Development (CRD) Program which assists rural people in identifying the services they need for economic, social, and cultural growth and helps them secure those services.

Rural Electrification Administration

The Rural Electrification Administration has provided loans for construction of rural electric association cooperative facilities, transmission lines, and rural telephone systems throughout the basin where such utilities were not available. Additional loans were available for farm electrification and household appliances.

STATE PROJECTS AND PROGRAMS

The State Engineer is responsible for the supervision of Wyoming's water resources and is concerned with water resource planning in the state. The Wyoming Water Planning Program under his direction has developed the Wyoming Framework Water Plan.

The Wyoming Department of Economic Planning and Development is charged with the conservation and development of the water resources of the state. This includes conducting studies and other activities in connection with investigation, financing, and construction of proposed water resource projects.

The Wyoming Game and Fish Department, in addition to its fee lands, manages various wildlife management units through various agreements with federal land administering agencies (table II-2, page II-8). These units provide winter range for big game animals, upland game and waterfowl habitat, fish rearing facilities, and public access for hunting and fishing. The Department also cooperates with USDA agencies in providing technical assistance to landowners who want to improve fish and wildlife habitat. A regular and successful program of the Department is to provide public access areas for water-based hunting and fishing.

The Wyoming Recreation Commission administers Boysen and Buffalo Bill State Parks. These are located on the reservoirs of the same names in Wyoming. It also provides and administers several monuments and information sites in the basin. An important new program provides facilities for snowmobile users.

The Montana Department of Natural Resources in cooperation with the Fish and Game Department operates Cooney Reservoir for irrigation and recreation. The total storage at Cooney is 27,515 acre-feet, of which 24,000 acre-feet are used for supplemental irrigation. This was the first "Water Board" project in Montana. The Department also has a state water planning program, rangeland resource program, and a forestry resource program.

The Montana Fish and Game Department has developed facilities at Cooney Reservoir and fishing access sites along Rock Creek, Stillwater River, Bighorn River, and Bluewater Creek. There is a fish hatchery on Bluewater Creek.

The Wyoming State Department of Agriculture works with farmers, ranchers, and agriculture based businesses in the state to assist them in meeting the needs of the present and future, to improve the economy, and to maintain the high quality of food products. Divisions of the Department administer weed and pest control, weights and measures inspection, food quality inspection, animal and plant disease control, research, information, planning, and development programs.

The Wyoming State Forestry Division is currently participating in the Bighorn Basin RC&D Project and has several forestry resource cooperative programs in the area. Cooperative agreements between the Division, the U.S. Forest Service, and Big Horn, Park, and Washakie Counties have been made for land use development, protection, planning, and coordination.

These and other state agency programs are described in more detail in corresponding chapters of the State Supplements to this report.

PROJECTS AND PROGRAMS OF OTHER FEDERAL AGENCIES

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) provides technical assistance and social services to Indians on the Crow and Wind River Indian Reservations. The special programs for Indian citizens are related to the administration of trust lands and water rights. Indian reservation lands comprise over 18 percent of the total area of the basin. The limits of Indian water rights are presently undefined and very controversial.

Indian claims to the use of water are predicated upon principles set forth in the Winters vs. U. S., a 1908 Supreme Court case, which held that there is an implied reservation of rights to use water by and for the Indians in the springs, streams, lakes, or other sources of water which arise upon, border, or traverse their lands. These claims remain indefinite in the amount of water to be owned or used by or for the Indians, and several court cases and legislative bills are pending action. The determination of the limits of these rights may have a significant impact on the development of water resources in the basin.

Irrigation development by the BIA on the Crow Indian Reservation started with the Reno Unit in 1885. This was followed by the Soap Creek Unit in 1894 and other units in later years for a total of 11 units under the Crow Irrigation Project. The largest of these units is the Bighorn Canal Unit with 21,800 acres irrigated. Total land irrigated in Big Horn County amounts to 63,058 acres, including the private development of 14,100 acres under the Two Leggins Canal. All development is from direct diversion except for offstream storage in the Willow Creek Reservoir near Lodge Grass.

There are a number of ditches and canals on the Wind River Indian Reservation. Perhaps the most significant is the Dinwoody Canal. Nearly 39,000 acres on this reservation are irrigated from projects developed through federal assistance.

Considerable work on range utilization improvement is under way with development of springs, wells, and pipelines for stockwater supplies and grazing dispersal. A recreation complex and a carpet factory have been developed at Crow Agency to improve employment opportunities. The Pretty Eagle recreation development near the north end of the Bighorn Recreational Area is nearing completion and will add to employment opportunities.

Bureau of Reclamation

About 211,200 acres of cropland have been or are being developed in the basin through reclamation projects. The existing projects are listed below:

a. Owl Creek Unit

This is a project which includes a storage dam and pumping facilities to ultimately provide supplemental water to 13,123 acres of irrigated land. Water is presently pumped from the Bighorn River to supplement the supply obtained from Owl Creek for about 3,210 acres of land in the Lucerne Area. When finally completed and sealed, Anchor Reservoir will store 17,300 acre-feet of water to assure a supply for about 9,913 acres. In 1972, 10,921 acres were being irrigated.

b. Boysen Unit

The Boysen Dam is a flood control, power, and flow regulation dam for irrigation, municipal, and industrial uses. The Boysen Unit improves downstream late water supplies and provides supplemental water for upstream lands by exchange, but no irrigation development is included in the unit. In 1972, 50,520 acres received a supplemental water supply from Boysen Reservoir.

c. Shoshone Project

This project is based on storage and flow control by Buffalo Bill Dam. Irrigated lands in this project extend from Cody to Kane, Wyoming, and include about 92,814 acres presently irrigated by the project. Power is generated at Buffalo Bill Dam and at Heart Mountain Power Plant.

d. Hanover-Bluff

This is a pumped water supply project using Bighorn River water controlled by the Boysen Dam. There are 7,301 acres presently irrigated by this project.

e. Riverton Reclamation Project (Now a unit of the Pick-Sloan Missouri Basin Project)

Water is diverted from the Wind River near Morton to supply about 54,281 acres of irrigated land from Pilot Butte to the Boysen Reservoir. Bull Lake provides storage for this project. Power was generated at Pilot Butte Reservoir until 1973. About 56,487 irrigable acres are available for water service by the existing project.

f. Yellowtail Dam

The Bureau of Reclamation's Yellowtail Dam and Bighorn Lake and the proposed Hardin Unit irrigation project dominate the current water development scene in the Montana portion of the basin. The dam was completed in 1967 and provides storage capacities of: 259,000 acre-feet for flood control, 250,000 acre-feet for joint use flood control and conservation, 364,000 acre-feet of conservation

storage, 483,000 acre-feet of inactive storage, and 19,000 acre-feet of dead storage for a total capacity of 1,375,000 acre-feet. Historical average annual streamflow at the dam site is 2,531,000 acre-feet. The 42,600 acres of irrigation on the Hardin Unit are expected to use 131,700 acre-feet of diverted water with a net depletion of about 68,500 acre-feet with 63,200 acre-feet of return flows.

g. Huntley Irrigation Project

The Huntley Irrigation Project was started by the Bureau of Reclamation in 1905 in Yellowstone County, Montana. Water is diverted from the Yellowstone River about 15 miles east of Billings, and the project extends to Pompeys Pillar, about 36 miles east of Billings. Water for about 29,240 acres is provided by this project.

Bureau of Land Management

The Bureau of Land Management (BLM) of the Department of the Interior has the responsibility for administering the use of public domain lands and for conservation measures and land treatment on lands in the Bighorn Canyon National Recreational area. BLM administers 26 percent of the land area of the basin. They have conducted an intensive study of these lands and prepared a Land Planning and Classification Report in 1953. More recently they have applied land treatment practices toward erosion reduction and better range use. BLM is employing the multiple use concept of public lands and is developing some recreational facilities. Preservation of the fragile desert ecology will be an increasing problem as recreational use increases. Some effort is under way to identify and preserve archeological sites in the Pryor Mountain area. A study funded jointly by the Bureau of Land Management, National Park Service, and Forest Service has begun inventorying the archeological resources of the basin. Preliminary findings show that the resource is extensively distributed throughout the basin, and that there has been prolonged human habitation. Much of the resource is found in remote areas and remains in good condition. Efforts to control the use of this resource should be made to prevent destruction of this historical component of the basin.

Existing project of Corps of Engineers

The town of Greybull is protected against frequent flooding and ice jams of the Bighorn River by about 14,000 feet of levee constructed by the Corps of Engineers. The Corps also has authority to provide regulations for existing dams in the basin to prevent or reduce flood damages.

PRIVATE DEVELOPMENTS

Although federally developed and assisted irrigation projects are extremely important to the economy and social welfare of the river basin, about 60 percent of the irrigated area has been privately developed.

Individual systems on farms and ranches comprise a noteworthy part of this development. More impressive are the group enterprise developments, most of which were developed under the Carey Act, which have built reservoirs, canals, laterals, diversion dams, and control structures to provide water to many farms. These systems are constantly being improved through private initiative, often with the assistance of the programs administered through the USDA as described earlier in this chapter. New private developments are still possible and can be assisted through state programs also described earlier in this chapter.

The private development of land resources is increasing in the basin, especially in the areas of recreation and minerals. Because of the attractiveness of the area, subdivisions for year-round and part-time occupancy homes are increasing in number. The proximity of private lands to the more aesthetic recreation resources provides opportunity for development of high quality private recreational facilities at reasonable costs. These developments lessen the pressure of recreationists on public facilities. They broaden the area absorbing the recreational burden. Expanded mineral exploration is under way by the mining industry, and extraction may increase if market conditions continue to make it economically feasible. The recent interest in this area has stemmed from increased mineral prices and improved mineral retrieval technology.

Recreational and mineral developments impose related environmental and service costs on area users. If these effects are not minimized, many of the basin's desirable attributes may be jeopardized.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

The purpose of this chapter is to describe some of the physical capability of water and related land resources to support development in the basin. These potentials are not aligned with specific projects or programs, but are identified with particular problems and needs. The reader should keep in mind that economic, legal, sociological, and political restraints and limitations are generally not considered in discussing these resource potentials. Tradeoffs are not considered, and the development of a resource for one purpose may reduce its development potential for another purpose.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

Potential for increased production on presently irrigated cropland

Much of the presently irrigated cropland is producing less than its sustained yield capacity. About 85 percent of the irrigated land in the basin could have significantly improved production through improved management, water supplies, land treatment, and water distribution systems. Irrigated land in the basin could be capable of up to 50 percent increase in total crop production.

About 37 percent or 282,000 acres of the presently irrigated cropland would have increased yield if provided a full supply of irrigation water. Most of these are haylands or pastures. If supplemental water could be supplied to these lands for second and third growth periods, they could support increased production of 50 percent or even more over present yields. With a full water supply there would be increased economic incentive for improved management, land treatment, and water distribution systems.

The use of irrigated hay and pasture lands is intimately related to the use of private and public rangelands. Improved production and management on irrigated lands should be balanced by corresponding improved treatment and management of the rangelands.

Potentially irrigable land

Data from soil surveys and reconnaissance studies of the basin indicate that large tracts of land, not presently irrigated, are suitable for irrigation. These potentially irrigable lands have suitable soils and land slopes for irrigation.

Probably the most active irrigation development at this time in the nation and in this basin is the private application of sprinkler systems both to presently irrigated and irrigable land. For example, the Wyoming Department of Economic Planning and Development has financially assisted the development of 6,600 acres of sprinkler irrigation in the basin in Wyoming since 1964.

In Wyoming nearly all of this land is presently grass or brush rangeland. A large portion of these lands are owned by the federal government, but some are state or privately owned. In Montana much of the irrigable land is presently dry cropland under private ownership.

Table VII-1 lists 1,360,750 acres of irrigable lands by general location in the basin with estimated water diversion requirements. Figure VII-1 shows specific locations. Many tracts are adjacent to presently irrigated lands. Some could be served by existing canals if additional water were provided. Other tracts could be served by extensions of existing irrigation systems. Most would require new surface or ground-water development projects to obtain water supplies.

Potential for increased production on range and dry pasture land

If all private and state range and dry pasture land were to receive improved management and treatment where needed, they could produce an estimated additional 609,800 animal unit months (a.u.m.) of roughage feed for domestic livestock and grazing wildlife. This corresponds to an increase of 0.13 a.u.m. per acre (or about a 62 percent increase) on 4,812,950 acres of this land needing improved management and treatment.

In some areas there is still potential for conversion of range to dry cropland. In Montana this amount to 1,345,000 acres. On cropable sites with adequate moisture and soils, the economic difference between returns from fallow-dryland cropping and range is heavily in favor of cropping. Most of these lands are in Big Horn and Yellowstone Counties in Montana.

Land for other uses

The availability of lands for residential, industrial, or recreational purposes may be in some competition with agriculture. The most nearly level lands with good internal drainage are most desirable for urban and industrial tract development. These same general conditions are desirable for irrigation development. Strip mining, where practical, is the most efficient way to extract coal and uranium, but this interrupts and changes existing agricultural uses.

Even though some conflicts in land use will occur, there is enough land for both agricultural and nonagricultural purposes if development is properly planned. For example, land otherwise desirable for urban purposes may be in a frequently flooded area; and agriculture, parks, and other more flood tolerant uses should be planned.

Recreational uses of land will compete with range and timber production. Recreational uses of water and water surface areas tend to compete with irrigation diversions to irrigated lands.

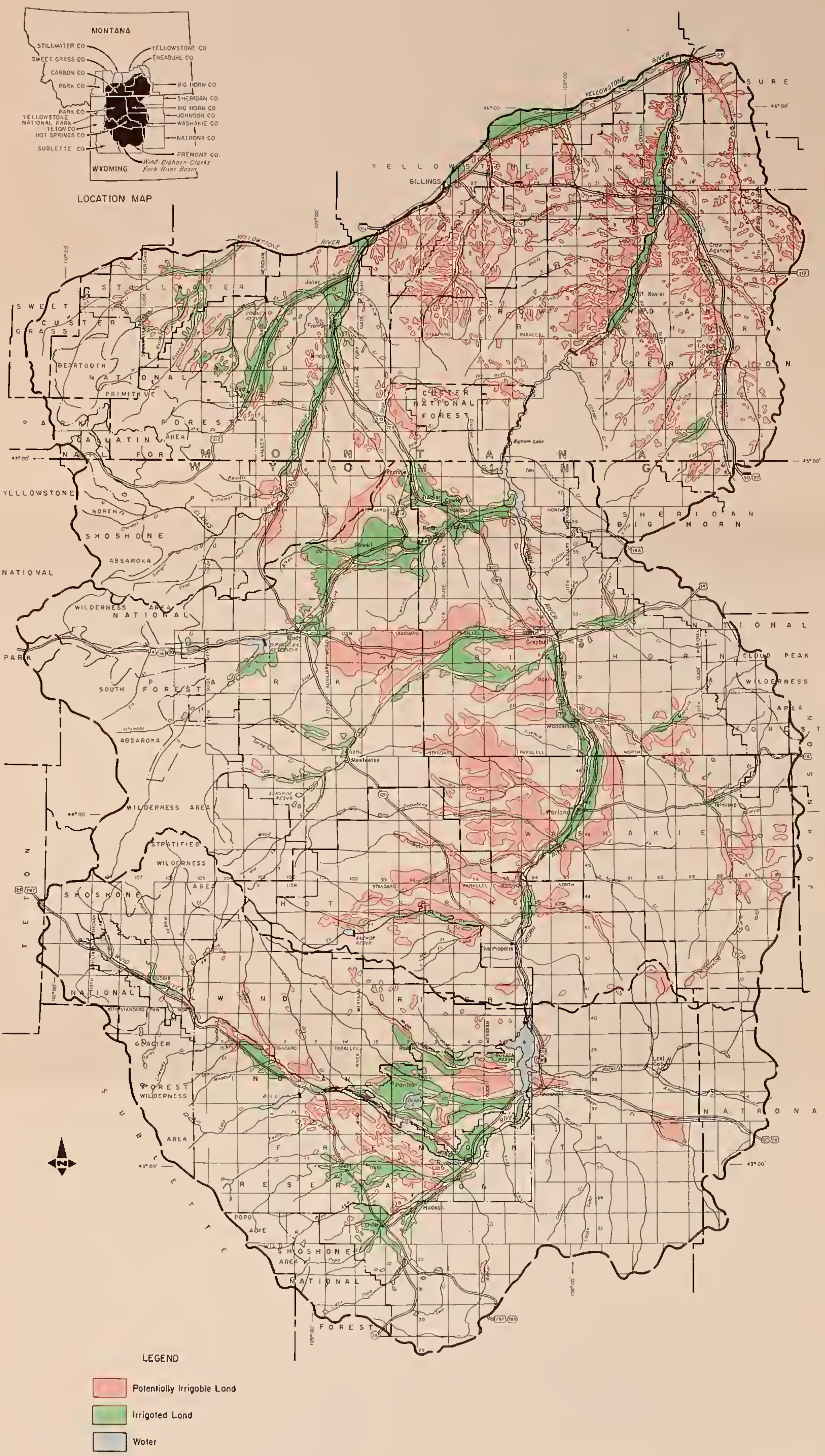


FIGURE VII-1

IRRIGABLE AND IRRIGATED LAND

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

MZ-EN-22441G

Table VII-1--Irrigable land and estimated irrigation water requirements by subbasin and state

Subbasin	Irrigable area	Water diversion requirement
	---acres---	---1,000 acre-feet---
Wind River	181,600 1/	696 2/
Bighorn River in Wyoming	642,800	2,678
Bighorn River in Montana	187,890	688
Subtotal for Bighorn River	830,690	3,366
Clarks Fork River in Wyoming	41,600	166
Clarks Fork River in Montana	56,520	211
Subtotal for Clarks Fork River	98,120	377
Little Bighorn River in Wyoming	9,600	32
Little Bighorn River in Montana	68,350	237
Subtotal for Little Bighorn	77,950	269
Stillwater River	12,830	47
Yellowstone minor drainages	159,560	609
Total Wyoming	875,600	3,572
Total Montana	485,150	1,792
Total river basin	1,360,750	5,364

1/ This estimate is based on soils and topography information and is for the entire Wind River Subbasin. The Bureau of Indian Affairs has estimated 199,000 acres of potentially irrigable land on the Wind River Indian Reservation alone.

2/ These diversion requirements are estimated for surface irrigated projects. Diversion requirements will be less per acre where sprinkler systems are installed.

POTENTIAL FOR WATER DEVELOPMENTS

Surface water

About 63 percent of the presently irrigated croplands in the basin benefit from an abundant basic water supply. Some of these lands fail to receive a full supply for their crops because of inefficiencies in transportation, management, and application of irrigation water. If project irrigation efficiencies were increased 10 percent, about 260,000 acre-feet less water could be diverted for irrigation each year, irrigated lands would be more evenly irrigated, increased production would result, and instream water quality would be enhanced. This total does not represent a net savings of water, however, since some of this water presently returns to the natural streams as surface runoff and ground-water return flow.

The potential for saving water through increased efficiencies is less in areas where the streamflow is not large enough for a full season irrigation supply. Some of the irrigated lands on the basin get less than one complete irrigation application in dry years. Increased efficiencies on these lands would result in increased production, improved water quality, and better land use. However, the main incentive to increase water use efficiency on these lands is to use the water on additional adjacent lands with the result of a net reduction of water to downstream areas.

There are about 241,600 acres of phreatophyte areas in the basin. About 80 percent of this area is natural. The remaining 20 percent is associated with agricultural irrigation development. Phreatophytes use about 600,800 acre-feet of water each year. Any reduction in consumptive use of water in phreatophyte areas should result in a net water savings of nearly the same amount. If a 25 percent reduction of phreatophytes in 20 percent of the area and a 10 percent reduction in 80 percent of the area could be achieved, about 78,000 acre-feet of water would be saved each year. This might be achieved through chemical and mechanical removal of plants, channel modification, improved agricultural water management, drainage, or other means. Any attempt at phreatophyte reduction in this basin should be carefully evaluated with regard to effects on fish and wildlife habitat and to costs of alternative ways to save water.

Additional development of water for irrigation would require new systems of diversion, pumps, canals, pipelines, and storage reservoirs. Even in the most water-short areas, there is water that could be stored during high spring flows and short summer floods. The mainstreams of the Wind River, Bighorn River, Clarks Fork River, Shoshone River, Stillwater River, and several of their major tributaries are water-abundant areas which supply most of the more than 4,000,000 acre-feet flowing from the basin annually.

A number of possible reservoir sites have been identified and are shown in figure VII-2. Additional information about these sites may be found in the Montana and Wyoming Supplements to this report. In this

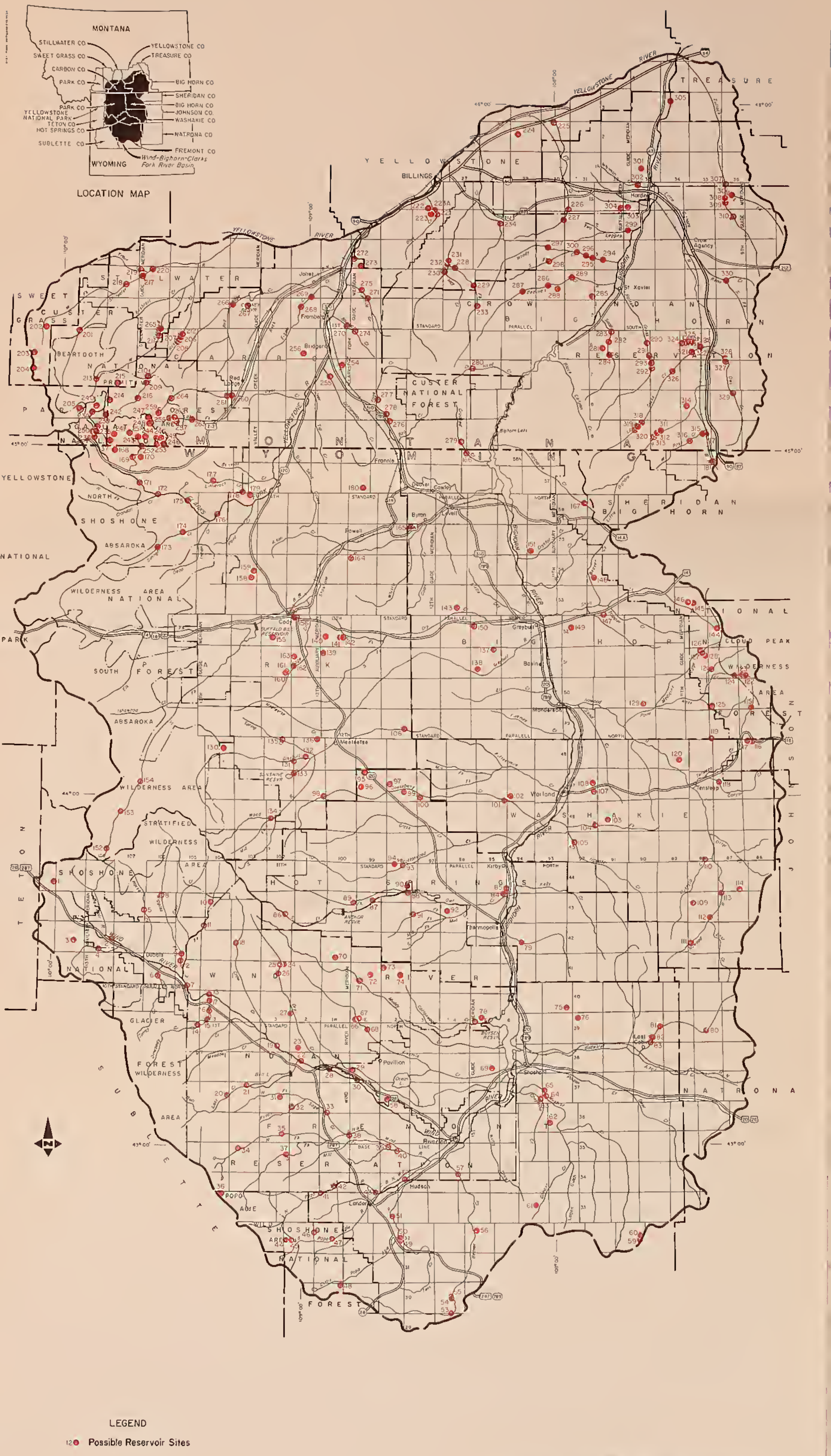


FIGURE VII-2

POSSIBLE RESERVOIR SITES

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

report the term "possible reservoir site" means only that a topographically favorable reservoir site exists and that some information about potential capacity or intended purpose is available. A number of these sites may be unfavorable because of poor foundations or high construction costs.

If sites could be developed to store all available storable water within water-short areas, there would still be water shortages in some areas. If this shortage is to be reduced, new water sources must be developed. One source might be transfer of surface water from the larger streams in the basin. For example, it is physically possible to build aqueducts from upper Wind River to provide supplemental irrigation water to most of the presently irrigated lands in the central portions of the Wind River and Bighorn River Subbasins. Some of the irrigable land in the basin could also be supplied this way. However, this system would be very expensive and probably not economically feasible at present. Large storage reservoirs would be needed to make the system efficient and provide late season water. Uncertainty with regard to appropriated versus reserved water rights also restrains development of transfers at this time.

There is potential for developing new pump systems to lift water from the mainstems of some of the larger rivers. For example, it is possible to pump water from the Bighorn River to supply water-short areas in the lower portions of tributary watersheds. Pumping and installation costs rapidly increase as distances, pumping pressures, and amounts of water increase. Large scale developments of this type will be limited by these factors.

Some projects for development of new lands through storage and transfer of water within the basin have been proposed by the Bureau of Reclamation. These are discussed in more detail in Chapter IX of this report. More information can be obtained from the Bureau of Reclamation.

Additional hydroelectric power can be developed in the basin. There is a power reservation site on East Rosebud Creek. There is no readily available estimate of power potential, but the estimated cost of storage is only $25 per acre-foot, and the 80 percent chance yield is about 116,000 acre-feet. Another potential site is in Clarks Fork Canyon in Wyoming. The Bureau of Reclamation has estimated that this site can develop 177,500 kilowatts. Both sites would also provide recreation and other benefits.

While there are ecological and economic arguments which favor hydrogeneration over using available resources of fossil and fission fuels, the potential for hydropower falls far short of the power needs of the nation and the region. Most of the electric power generation in the near future in this region will probably come from coal-fired, steam-powered generating plants. These plants generally use about 15,000 acre-feet of water per year per 1000 megawatt plant. Most of them will be located outside this river basin but may transport water from this basin.

There is potential for transfer of water from this basin for coal and power development outside the basin in eastern Wyoming and Montana.

Water stored in Clarks Fork Canyon could also be used by thermoelectric generating plants on the Yellowstone River. The cost of development and the value of water for other uses would seem to be ultimate determining factors in the case of local versus distant use.

Ground water

Ground water in amounts up to 450 gallons per minute (g.p.m.) from depths of less than 100 feet can be developed in valley alluvium along major drainages in the basin. The potential for large scale water development from valley alluvium is limited because of thin aquifers and the possibility of depleting surface flows in associated streams.

Up to 25 g.p.m. may usually be obtained within depths less than 600 feet on the basin floor in bedrock formations of the Tertiary Age. Steeply inclined older formations outcrop around the margin of the basin floor. Aquifers in these formations may yield sufficient water with artesian pressure for irrigation use. Depths to these aquifers vary widely as does the quantity and quality of water obtained from them. The potential for large producing wells of this type is restricted to a narrow band along the margin of the basin floor, and careful site selection is required.

The potential for artificial recharge of aquifers is very limited in the basin. If new lands are developed on the benches in the midwestern portion of the Bighorn River Subbasin, a shallow body of ground water will probably form in gravel deposits which might provide potential for new wells.

Potential for municipal and industrial water supply

There is high quality surface water available for municipal and industrial development along the larger streams of the basin. Ground water may also be developed. However, ground water in some parts of the basin is highly mineralized and should not be used for human consumption.

POTENTIAL FOR CHANNEL IMPROVEMENTS AND LEVEES

There is potential for channel improvement, streambank protection, and levee construction to reduce erosion and flood damages along many of the streams and rivers in the basin. However, in practice, the installation of these measures is not generally economically justified except for short reaches to protect roads, railroads, towns, bridges, irrigation diversion structures, and high valued irrigated cropland. In some locations it may be better to relocate buildings out of the flood plain than to build levees to protect them. Some of the above practices may be installed for environmental reasons.

POTENTIAL FOR WATER TABLE CONTROL

The most suitable method to obtain water table control is to combine

Irrigation diversion on Rock Creek above Red Lodge needs to be replaced.

Golden Ditch diversion out of Clarks Fork River before reconstruction, 1959.

Golden Ditch diversion after reconstruction, 1961, eliminating annual diking and pollution of the river.

PLATE 32

improved irrigation water management and irrigation systems with improved drainage systems. On about 85 percent of the 145,900 acres of wet and saline soils in the basin, water table control can be improved through better irrigation water management systems. Nearly all of this same area would also benefit from improved drainage systems. About 30 percent of the area must have improved drainage systems to achieve effective water table control. Some of this area has been irrigated in the past, is not irrigated now, and will require some irrigation for full production after drainage is installed.

About 15 percent of the wet and saline soils of the basin cannot be effectively drained or improved for agriculture. Some of these areas can be managed as salt and water tolerant pastures or as wildlife pastures and recreational areas. It should be noted that marshlands, which are so vital to waterfowl and other species, are not included in the estimate of drainable lands. There is very little marshland in the basin, and no accurate estimate of its area is available.

POTENTIAL FOR IRRIGATION SYSTEM IMPROVEMENT

The physical potential exists to improve nearly all irrigation systems in the basin. This can often be accomplished best by a total system approach on a group project basis. Delivery systems can be upgraded by the installation of more efficent flood resistant diversion structures; division, control, and metering structures; and through canal consolidation, relocation, rehabilitation, and lining.

When properly designed and operated, ditch lining and land leveling can increase on-farm irrigation efficiency as much as 30 percent. Properly managed and constructed furrows and corrugations can increase field application efficiencies to 70 percent. Level and graded borders and sprinklers can increase field efficiency to 80 percent with good management. Conversion to sprinkler systems has the greatest economic potential where soils and climate will accommodate high value crop production. Where surface irrigation methods persist, there is potential for recycling tailwater. Most tailwater is of adequate quality for reuse as irrigation and livestock water. Land smoothing and leveling allow doubling of field irrigation efficiencies in some irrigated areas.

POTENTIAL FOR RECREATION DEVELOPMENT

Development potentials in recreation can be broken into two general categories. The first would consist of improving the use of existing opportunities and resources. A second consists of providing new opportunities and developments. Recreation use occurs on public as well as private lands in this basin, and both have a potential for expanding recreation opportunities.

Some of the public land areas have developed recreation facilities. Generally, these areas are accessible through some type of road or trail

system. However, recreation use is almost nil on a large part of the public land because of the lack of passageways or because these areas are "land-locked" behind a buffer zone of private land. Improved accessibility to public land is needed and can be accomplished by acquiring access across private land. Large blocks of public domain, national forests, and state-owned land are used on an annual basis by livestock producers. Grazing rights often have been and continue to be interpreted by the holder as rights to exclude all other users from multiple use of federal and state lands. Where the only practical entry to public land is across private holdings and if the multiple use concept is to be realized thereon, then access needs to be acquired through either negotiation or court action. This is one potential for providing much additional recreation opportunity at a relatively small annual cost.

Private lands near public lands may be the best opportunity to provide additional developed recreation facilities. This is the most likely way in which some types of recreation facilities can be provided when public construction funds for this purpose are limited. Public monies could then be used for purposes that supplement investments made in the private sector. There are good potential sites for either public or private campground development on or near public lands. If developed facilities can be provided by the private sector, public funds could be used for access roads, etc. Thus, recreationists will pay the relatively high costs of providing the facilities they desire while maximizing recreation opportunities for all persons through the public fund expenditure on access. It is possible that if recreation resource users have to pay the full cost of using this resource, their recreation preferences may change.

There may be a potential for developing small, lowland lakes that are close to towns and roads for use in water-skiing. Existing large bodies of water provide only limited use for water-skiers because the water is too cold much of the year. Also, the large surface area of the water can be adversely affected by winds and result in high wave action.

Sightseeing and pleasure driving are a part of the total recreation experience for most vacationers. Providing additional scenic areas should be considered, particularly when these areas purvey a varied view. About 400 square miles of mostly public land located east of Meeteetse, Wyoming, has considerable potential as a scenic area. It is an area of low rainfall, sparse vegetation, and a panorama of colored bluffs, hills, mesas, and plains. It is close to two major access routes between Yellowstone Park and the Bighorn Mountains. This area is at a relatively low elevation and could accommodate campers for longer periods than at a higher elevation. Also, this area could be used as a staging area campground for visitors headed toward national parks.

There is good potential for developing hunting and fishing access areas along streambanks and lakeshores. Such accesses can be purchased, governed, and managed by the states. Costs for land rights and providing facilities might be shared between federal and state funds.

POTENTIAL FOR FISH AND WILDLIFE HABITAT IMPROVEMENT

Fishery

Low streamflows in late summer, reservoir drawdown during spawning season, sedimentation, winter kill, undesirable fish populations, livestock disturbance of channels, infertile water, and oil field wastes are factors which prevent maximum desirable fish production in the basin. Control of these and other factors in the basin would improve fish and wildlife habitat. A table in each of the State Supplement Reports provides more detailed information about how this potential can be developed.

Big game

Big game herds could be increased if additional winter grazing were provided. This could be done through range restoration, selected forest thinning, erosion control, reduction of livestock grazing, plantings, construction of watering facilities, fertilization of winter ranges, and other practices.

Waterfowl

Waterfowl habitat is quite limited in the basin. Reservoirs and lakes are important habitat; but small ponds, reservoirs, and marshlands are extremely important to waterfowl, and these are quite limited in the basin. There is a potential to increase these small water areas. Waterfowl habitat can be further improved by providing more protected food, cover, and nesting sites near these small water areas.

Upland game and other wildlife

Habitat for upland game and other wildlife can be improved. Food, undisturbed cover areas, and watering facilities can be provided on private and nonprivate land.

POTENTIAL FOR WATER QUALITY IMPROVEMENT

Agriculture

Irrigation return flows contain dissolved minerals, sediments, and sometimes chemicals. The amount of these pollutants depends on soils, geology, type of irrigation, degree of water control, use of chemicals, and other farming practices. The latter four factors can be controlled. Sprinkler irrigation can be managed for zero surface runoff of irrigation water. Agricultural chemicals can be applied in a way to minimize downstream pollution. Tillage can be done to minimize soil loss. Grazing can be managed so a good ground cover is maintained and feedlot wastes can be controlled and treated. The control of feedlot wastes will become more important as cattle feeding expands in the basin. There is potential to increase these and other means of improving water quality through education and assistance in applying improved land and water management practices.

Municipal, industrial, and other urban uses

Federal and state laws require permits for waste discharge from towns, cities, industries, and others. Permits are issued in accordance with a program designed to eliminate pollution. There is potential to improve water quality by providing new or improved waste treatment facilities for several communities and local industries.

Recreation

Outdoor recreation is an important factor in the development of the basin. Wastes associated with recreation activities are costly to control because of their dispersion. One way to reduce this problem is to provide sanitary and waste collection facilities at intensive use areas.

ASSOCIATED LAND TREATMENT AND ADJUSTMENTS

There is some potential for land use conversion. The potential for conversion of rangeland to irrigated cropland was discussed earlier in this chapter. Changing some marginal cropland to wildlife habitat and recreation land could bring environmental, economic, and quality of life benefits.

FOREST LAND DEVELOPMENT POTENTIAL

Potential for outdoor recreation

The major forest landowners and management agencies have accurate and recent estimates of the potential for recreation development. The Bureau of Land Management and the Forest Service together are responsible for administering more than half of the land in the basin, including sites with a current capacity of about 1,660,000 visitor days per year. Another 998,000 visitor days of annual use can be satisfied on potential development sites inventoried.

There is additional potential for recreation site development on private forest land on the Wind River Indian Reservation, in state parks and other lands, and in Yellowstone National Park. With the additional undeveloped capacity of wilderness areas, Yellowstone Park, national forests, badlands, and other wild land in the public domain, it appears that the projected demand can be satisfied; and there would still be potential for additional recreation activities in the basin. One factor that could limit the realization of the full potential is lack of permanent public access to national forest land through Indian reservations and private land. These management and utilization potentials are also affected by significant changes in management objectives. The national forest lands, which were managed primarily for timber production in the past, are now managed to emphasize aesthetic, wildlife, and recreation values as well. The forest lands of the Wind River Indian Reservation are expected to be managed with a near total exclusion of timber management activities. These management policies will have both positive and negative effects on the potential uses

of reservation forest lands. The Forest Service is starting to emphasize recreation development at destination sites while de-emphasizing the roadside campgrounds that serve as little more than bedrooms for passing tourists. The development of roadside campgrounds is felt to be more appropriate for private investment, and they are beginning to emerge as the market expands. The Forest Service may provide assistance to private developments.

Potential for forest land grazing

No specific need or unfulfilled demand for grazing has been identified. However, there is a trend toward expanded livestock production. In the future there may be increased pressure on forest range. Before an increase in grazing is allowed, the alternatives should be carefully evaluated. Intensive management and installation of fencing, water facilities, and range revegetation could increase the grazing potential. Some changes in management philosophy could affect the distribution of use but not the capacity.

Potential development for timber

Although the theoretical potential for meeting the 2020 demand for timber exists, it is unlikely that the potential will ever be realized. The supply of timber could be increased by approximately 50 percent by decreasing current losses due to diseases and insects. Timber from land clearing, thinning, and other operations could be utilized more efficiently, and wood processors could improve utilization in their operations. This could provide about a 70 percent increase in usable wood. Finally, intensified forest management, reforestation and regeneration, and new methods of harvesting on stands not presently harvestable could provide a 50 percent increase in the wood supply.

Potential development for forest wildlife and fisheries

Most of the forest land is classed as summer range. This habitat can be manipulated and intensively developed to support more wildlife. The treatment would have little effect on wildlife populations, however, since the lower elevation winter range is more critical. There is potential to manage the winter range to support more wildlife. Much of the winter range is privately owned.

Stream fisheries can be improved, restored, or enhanced, and additional reservoirs can be developed to provide variety. The physical potential for fisheries development appears sufficent to satisfy projected demands.

Potential forest land development for water management and water quality

The needs for water management will be provided mainly through structural development and other project means. However, there may be potential for increasing water yield and prolonging water release through vegetative management in forest areas. Research is currently under way,

and early results are promising. However, there has not been enough application to justify extension of research findings from experimental areas to general forest areas. In addition, this basin has constraints on this type of work since most of the high elevation forests are classified as wilderness or primitive areas; and vegetative manipulation is prohibited by congressional statute. The primary water pollutant from forest land is sediment. There is potential for land treatment and regulation to reduce the causes of sediment production on lands not in primitive and wilderness areas.

ENHANCEMENT OF NATURAL BEAUTY

It is no longer practical to plan for development without considering visual effects. If the development is to harvest timber or to strip mine for coal, the public demands that trash be cleaned up, scars be healed, and the area be revegetated. Water storage and control structures and recreation facilities should be designed to fit the landscape of which they become a part.

Another way to enhance natural beauty is to complete the land treatment needed in the basin. This will heal erosion scars, improve vegetation, and reduce sediment pollution of water.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

This chapter describes identified opportunities for project development through USDA programs. Physical and economic impacts of these projects are discussed. Through the identification of these projects and their impacts, it is hoped that a coordinated, priority-oriented development can be accomplished. This report is a summary for the entire basin. More detailed information can be found in each of the state supplements, watershed investigation reports, and information in the files of the federal agencies involved in the study. The general provisions of USDA programs were discussed in chapter VI.

OPPORTUNITIES FOR WATERSHED PROTECTION AND FLOOD PREVENTION

Study procedures

There are 127 defined watersheds in the Wind-Bighorn-Clarks Fork River Basin. There are 83 entirely in Wyoming, 30 entirely in Montana, and 14 that have a part in each state. All were investigated, to some degree, to determine whether watershed projects would solve watershed problems or enhance resource development. Figure VIII-1 is a map showing the degree of investigation of the watersheds. Those watersheds shown on the map as having "cursory investigation only" were so limited in physical potential for project development that there was no detailed investigation. For the watersheds that appeared to have physical potential for project action, a detailed field investigation was conducted. If the detailed investigation showed that costs would exceed the benefits, no formal report was made. Where the potential for an economically feasible project was found, a watershed investigation report was written.

All of these proposed projects could be considered as having a high priority. However, a number of criteria, such as critical resource needs, economic return, and number of beneficiaries, were used to determine the watersheds with the highest priority. Three proposed projects in Wyoming and five in Montana have been selected as high priority watersheds.

An additional factor that needs to be considered in determining the priority of any project involving the storage of water for agriculture is that they should be developed as soon as possible so as to establish the rights for this use. After agriculture water rights are established, industry and other water users can generally afford to develop the remaining water supply whatever the cost. On the other hand, water storage for agriculture will probably not be economically possible if other interests obtain water rights first.

Summary of physical and biological effects of proposed watershed projects

Watershed investigation reports have been written and distributed for 21 potential small watershed projects in the basin. The impacts and land use changes for each of these proposed developments are listed in table VIII-1. A more detailed explanation of each project is contained in the state supplement reports.

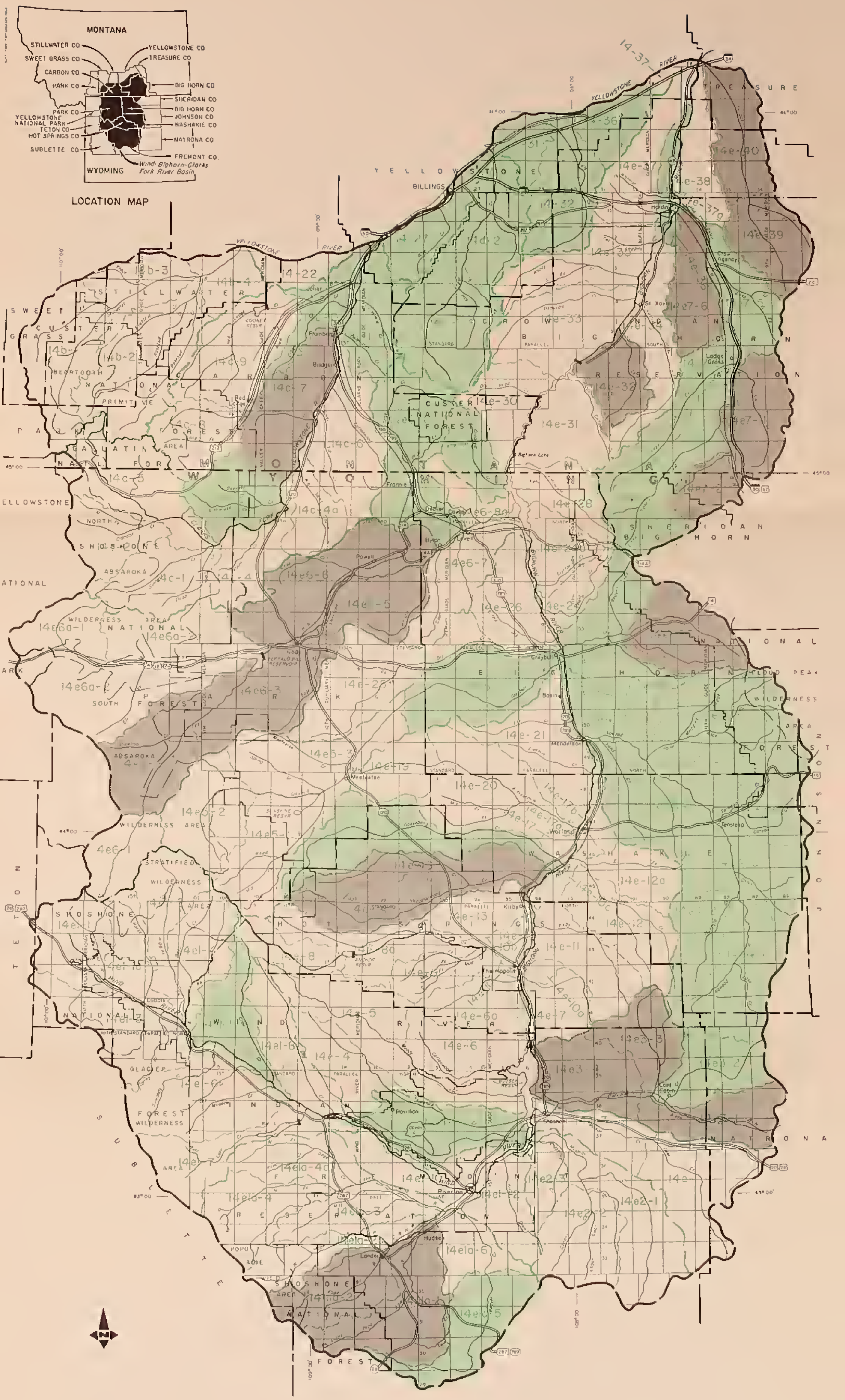
Development of the 21 small watershed projects will provide about 86,400 acre-feet of water available for improving late season irrigation water supplies each year. This same development would reduce annual streamflow from the basin by about 72,500 acre-feet. In-stream sediment would be reduced about 140 acre-feet per year by 14 reservoirs. Most of the proposed projects could provide improved waterfowl habitat. Some could improve fish, antelope, and upland game habitat. A few, notably Crow Creek near Tiperary and Upper Beaver Creek in Wyoming, would have some adverse effect on deer, elk, or moose habitat. This adverse effect could be mitigated through habitat improvement measures in these projects.

The completion of these projects would require some land use changes. About 27,000 acres of rangeland would be converted to irrigated cropland. About 31,000 acres of cropland with poorly drained and saline soils would be improved. Nearly 3,300 acres of land would be converted to water surface, and about 1,600 acres near these new bodies of water would be converted to recreational use. The combined capacity for recreation in the basin could be increased as much as 200,000 visitor-days each year.

Economic impacts of proposed watershed projects

Installation of watershed projects proposed in this study can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate, if not impossible, task to quantify all effects likely to occur. The basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes, and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) The basic group which includes agriculture, forestry, manufacturing, and mining produces goods and services for consumption mainly outside the basin; and (2) the derivative or service-oriented group which includes those industries whose goods and services are mainly consumed locally. Some services would be considered basic in that service sold to tourists brings new money into the basin. Tourist service activity has not been measured in this study. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a chain reaction in motion that is reflected through all sectors of the economy.



WATERSHEDS INVESTIGATED FOR SMALL PROJECT ACTION

- Watershed investigation report completed
- Detailed field investigation but no report published
- Cursory investigation only

FIGURE VIII-1

WATERSHEDS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Table VIII-1--Summary of potential small watershed projects and their impacts, Wind-Bighorn-Clarks Fork River Basin

Watershed number and name	ECONOMIC IMPACTS: BENEFITS: Annual Benefits 1/	COSTS: Total installation cost	COSTS: Annual cost 2/	Benefit to cost ratio (annual)	PHYSICAL AND BIOLOGICAL IMPACTS: Average annual surface water quantity change	Water supply timing improvement	Sediment load reduction	Vegetation improvement	Erosion reduction	Fish and wildlife: Location with improved habitat	Fish and wildlife: Location with reduced habitat	Increased recreational use	People served with new community water supply
	$/yr	$	$/yr	ratio	AF/yr	AF/yr	AF/yr	acres	acres	acres of land or water or miles of stream		visitor days/yr	number
PRIORITY WATERSHEDS													
WYOMING													
14e5-4 Lower Greybull	821,000	3,900,000	264,580	3.1:1.0	+3,000	0	0	31,600	31,600	10,400 ac.	0 ac.	37,000	0
14e4-1-7 Nowood River Watersheds	200,370	1,627,500	111,220	1.8:1.0	-3,500	13,000	55	3,000	3,000	3,550 ac.	3,560 ac.	-	0
14e-15 Gooseberry Creek	71,000	832,000	51,400	1.4:1.0	-1,400	3,665	0.25	0	0	175 ac.	175 ac.	-	0
MONTANA													
14-27 Blue Creek	252.870	3,183,810	206,590	1.22:1.0	-420	2,460	9.5	-	-	5 mi.	0	17,610	400
14d-1&2 Pryor Creek	365,450	2,797,300	188,980	1.93:1.0	-6,265	9,902	28.0	4,207	-	0	2 mi.	57,275	-
14e-37g Two Leggins Irrg. Unit	648,790	5,147,370	342,100	1.90:1.0	-	-	-	8,900	-	nil	nil	-	-
14e7-1 Upper Little Bighorn River	100,700	436,520	26,850	3.75:1.0	-5,800	-	-	2,900	-	0	0	-	-
14e7-3 Lodge Grass Creek	41,000	580,630	34,900	1.17:1.0	-	-	5.4	-	-	0	6 ac.	3,375	-
Subtotal	2,501,180	18,505,130	1,226,620	2.04:1.0	-14,385	29,027	88.15	50,607	-	-	-	-	-
OTHER WATERSHEDS 3/													
WYOMING													
14e6-8 Sage Creek-Pryor Mountain	122,180	1,063,770	65,580	1.9:1.0	-600	1,480	1	0	0	170 ac.	170 ac.	-	0
14e-23 Lower Shell Creek	51,500	546,900	34,120	1.5:1.0	-1,300	3,370	1	0	0	203 ac.	213 ac.	-	0
14e1-5 Crow Creek near Tiperary	118,230	854,000	52,210	2.3:1.0	-1,600	9,900	1	2,600	2,600	2,845 ac.	2,845 ac.	-	0
14c-5 Cyclone Bar	134,240	840,000	58,030	2.3:1.0	-1,700	4,950	3	0	0	400 ac.	400 ac.	-	0
14e1a-5 Upper Beaver Creek	109,735	968,800	60,400	1.8:1.0	-1,400	12,900	16	766	766	1,196 ac.	1,196 ac.	-	0
14e-27 Crooked Creek	36,900	234,500	17,850	2.1:1.0	-3,100	7,000	0	0	0	0	0	-	0
14e3-2 Upper Badwater Creek	39,120	546,000	33,340	1.2:1.0	-400	1,620	1.5	0	0	70 ac.	70 ac.	-	0
14e1-9 Midvale	580,550	2,490,730	237,250	2.4:1.0	-35,000	0	0	16,830	16,830	16,830 ac.	16,830 ac.	-	0
14e1-9 Hidden Valley	57,400	253,500	15,970	3.6:1.0	-300	-	0.6	0	0	28 ac.	28 ac.	-	0
MONTANA													
14e7-5 Little Bighorn East Side	93,860	355,730	27,520	3.41:1.0	-4,540	-	0.0	2,270	-	-	-		
14-31, 32, & 36 Huntley Irrigation Project	383,000	1,952,600	125,320	3.06:1.0	-	-	-	11,700	-	nil	nil	-	-
14c-10 Elbow Creek	209,665	1,790,600	117,510	1.78:1.0	-5,550	10,450	7.0	1,400	40	0	35 ac.	41,135	-
14c-11 Bluewater Creek	230,650	1,900,280	127,050	1.82:1.0	-2,600	5,698	11.0	5,334	-	5 mi.	0	46,220	-
Subtotal	2,167,030	13,797,410	972,150	2.23:1.0	-58,090	57,368	42.1	40,907	-	-	-	-	-
TOTAL	4,668,210	32,302,540	2,198,770	2.12:1.0	-72,475	86,395	140.25	91,507	-	-	-	-	-

1/ Additional information may be found in State Supplements and Watershed Investigation Reports.

2/ Installation cost amortized at 5 5/8 percentage rate plus annual operation and maintenance costs.

3/ Some of these watersheds may become priority watersheds.

Table VIII-1--Summary of potential small watershed projects and their impacts
Wind-Bighorn-Clarks Fork River Basin
(Continued)

Watershed number and name		LAND USE AND AVAILABILITY CHANGES							Potential for state agency involvement
		Rangeland to cropland	Wetland to improved cropland	Cropland to wildlife and recreation land	Rangeland to recreation land	Land to water surface	Cropland with improved production	Rangeland with improved production	
		acres							
PRIORITY WATERSHEDS									
WYOMING									
4e5-4	Lower Greybull	0	10,400	0	0	N/A	31,600	-	Development of Badlands Scenic Area
4e4-1-7	Nowood River Watersheds	3,000	0	0	10	550	0	-	Irrigation and recreation cosponsor
4e-15	Gooseberry Creek	0	0	0	0	175	2,110	-	Transwatershed water development
MONTANA									
4-27	Blue Creek	0	0	0	320	168	0	-	Recreation cosponsor
4d-162	Pryor Creek	2,285	0	200	800	335	1,922	2,285	Irrigation and recreation cosponsor
4e-37g	Two Leggins Irrigation Unit	0	8,900	0	0	0	8,900	-	________
4e7-1	Upper Little Bighorn River	0	0	0	0	0	2,900	-	Irrigation cosponsor
4e7-3	Lodge Grass Creek	0	0	0	27	27	0	-	________
Subtotal		5,285	19,300	200	1,157	1,255	47,432	2,285	
OTHER WATERSHEDS									
WYOMING									
4e6-8	Sage Creek-Pryor Mountain	0	850	0	0	170	4,850	-	Recreation cosponsor
4e-23	Lower Shell Creek	0	0	0	10	203	1,940	-	Recreation cosponsor
4e1-5	Crow Creek near Tiperary	2,600	0	0	0	245	1,200	-	Irrigation and recreation cosponsor
4c-5	Cyclone Bar	0	0	0	0	400	5,060	-	________
4e1a-5	Upper Beaver Creek	766	0	0	0	430	2,034	-	Recreation and wildlife cosponsor
4e-27	Crooked Creek	0	0	0	0	0	1,400	-	________
4e3-2	Upper Badwater Creek	0	0	0	0	70	1,700	-	Recreation cosponsor
4e1-9	Midvale	15,580	0	0	0	0	0	-	Irrigation cosponsor
4e1-9	Hidden Valley	0	0	0	0	28	2,362	-	________
MONTANA									
4e7-5	Little Bighorn East Side	1,135	0	0	0	0	1,135	1,135	________
4-31,32, & 36	Huntley Irrigation Project	0	11,700	0	0	0	11,700	-	Drainage cosponsor
4c-10	Elbow Creek	500	0	0	400	235	6,182	500	Irrigation and recreation cosponsor
4c-11	Bluewater Creek	0	0	0	0	235	5,354	-	Irrigation and recreation cosponsor
Subtotal		20,581	12,550	0	410	2,016	44,917	1,635	
TOTAL		25,866	31,850	200	1,567	3,271	92,349	3,920	

A ratio of basic employment to derivative employment was computed from U. S. Census of Population reports for each subbasin. This ratio is not static. The number of employees in the derivative group is becoming larger relative to the basic group over long periods of time. This trend is expected to continue. A basic-derivative ratio applicable to the entire basin for year 2000 is estimated at 1:3.25, derived from the following table:

Year	Part of basin	Total	Basic employment	Derivative employment	Basic-derivative ratio
1940	Wyoming	15,953	8,765	7,188	1:0.82
	Montana	8,512	5,476	3,036	1:0.55
1950	Wyoming	22,001	9,167	12,834	1:1.40
	Montana	8,610	4,798	3,812	1:0.79
1960	Wyoming	24,790	9,111	15,679	1:1.72
	Montana	7,847	3,465	4,382	1:1.26
1970	Wyoming	25,289	8,416	16,873	1:2.00
	Montana	7,085	2,572	4,513	1:1.75

Basic-derivative ratios for the state portions were weighted by agricultural employment to arrive at the estimate for the basin.

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 122,000 acres in the investigated watersheds will be affected. Changes in land use are expected on only part of the total; however, nearly all of the benefited area will be used more intensively and efficiently. Hay, silage, and feed grain production will be increased while pasture and range production will decline because of fewer acres.

By 2000, with the resource developments in place and operative, the annual gross value of agricultural production will be increased $7,404,000. Approximately 54 percent of the increase ($4,004,000) will come from lands that are irrigated at the present time but need either additional water or the removal of excess water. Supplemental irrigation water will be provided by the projects. The remaining 46 percent ($3,400,000) will come from land that is currently used for grazing and dryland crops but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the basin and will contribute to economic development objectives. To the extent that additional agricultural production and associated economic activity merely displaces production and activity in other areas or affects market prices, the benefits may not truly be national gains. Agricultural products of this basin are not of the type heavily influenced by international exports. Therefore,

this study assumed that output increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of production per agricultural employee in the year 2000 is estimated at $34,230. 1/ If it is assumed that agricultural labor resources will be fully employed in 2000 without the plan, the additional agricultural output will provide for 214 additional basic employees. By applying the employment multiplier, it can be shown that derivative employment can increase by 696. The total impact on employment resulting from the increased agricultural production associated with the programs is estimated to be as much as 910 employees. This is comparable to providing for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $380 of net farm income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $2.9 million) can be considered as income to the basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the basin, and in turn, respent within the area until its marginal effect becomes zero. A summation of these successive rounds of spending is commonly called the income multiplier. This indicator measures the total change in a particular sector. Recent studies in areas similar to the basin estimate the income multiplier to be about 2.0. If the entire $2.9 million were dispersed in the basin, the total income effect would be at least $5.8 million annually, which is an average of $50 per resident. No attempt was made to project the income multiplier for 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a somewhat similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of the costs for watersheds investigated in this study is estimated to be $16,216,000. If a 15-year period is required for project installation and federal funds are provided in equal increments over the period, this is equivalent to $1,081,000 annually. All of this investment can represent new income to the study area provided that a local contractor is employed and he purchases capital, labor, supplies, and machinery within the study area. The local area could be enriched as much as $2,162,200 annually because the added increment of new investment income during the construction period is affected by the income multiplier.

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT OPPORTUNITIES

Project measure proposals in the Beartooth RC&D area and Bighorn Basin RC&D area of the basin deal with water, land, and other natural resource

---

1/ Gross value of agricultural production from table III-12 ($123,238,000) divided by the number of agricultural employees from table III-8 (3,600).

development, as well as for cultural development. Several proposals have been made for ditch consolidation and irrigation system rehabilitation and reorganization. A number of measures propose the irrigation of new land. A few propose flood control or drainage. Others involve fire protection, recreation developments, municipal water, fish and wildlife habitat improvement, predator control, improved forest practices, new or improved roads, hiking and riding trails, a grass and legume seed cleaning and processing center, sewer systems, airport expansion, and solid waste disposal systems. A number of cultural developments are also proposed. Many of the proposals can be developed as small group projects. A few would qualify as features of small watershed projects. Some will require federal assistance from agencies not in the U S. Department of Agriculture.

DEVELOPMENT OF A LAND TREATMENT PROGRAM

The concern for the proper use and management of land and related vegetative and water resources has been a primary reason for the existence of U.S. Department of Agriculture agencies since they were first created. The widespread practices of contour stripcropping, farm lot windbreaks, land terracing, gully plugs, selective forest cutting, and other such practices indicate a remarkable success in advancing the cause of proper land use in America. Nevertheless, much remains to be done before every acre of land is used according to its capabilities and treated according to its needs. Some of the practical opportunities for this basin are described in this section.

Land treatment for nonfederal lands

Proper and improved land treatment on nonfederal land is the basic concern of the Soil Conservation Service of the U.S. Department of Agriculture. Proper land treatment is the basic element of small watershed projects. Needed land treatment measures, regardless of land ownership, must be part of a watershed work plan. Acceleration of technical and financial assistance in developing land treatment measures can be provided to approved watershed project areas. Critical areas must be treated as a condition for federal assistance.

The conservation operations program of the SCS is an ongoing program to provide technical assistance and advice in soil and water conservation to landowners. Local conservation districts determine priorities for local programs. There is an opportunity to accelerate the application of land treatment practices through this program, also.

The Bighorn Basin Resource Conservation and Development Project (RC&D) in Wyoming and the Beartooth RC&D Project in Montana are both approved for operations. RC&D funds will make possible accelerated technical services for soil surveys, conservation planning, and financial assistance within approved specific project measure areas.

About 36 percent (3,309,340 acres) of the 9,176,220 acres of nonfederal lands in the basin are adequately treated. With a continuation of the existing rate of ongoing application, about 50 percent of the state and private land will be adequately treated by the year 2000. It will require a total of about $56,948,000 in installation costs to achieve this degree of land treatment. The improvement in land treatment will produce an increase of about 481,440 equivalent AUM's per year.

If the rate of application is accelerated to almost double the existing rate, about 67 percent of the state and private land can be adequately treated by the year 2000. A total of about $101,400,000 would be required to achieve this goal with the total increase in production estimated to be about 880,270 equivalent AUM's per year.

Table VIII-2 presents a more detailed analysis of the economic effects of either continuing the existing rate of land treatment application or the proposed accelerated program. An evaluation of this table shows that the major portion of the annual forage equivalent increase is a result of land treatment measures which are installed on irrigated cropland. This production increase has been estimated to be over two AUM's per acre. In addition to the production effects, these measures will improve irrigation efficiencies, control erosion, improve water quality, and reduce operation and maintenance costs.

The best rate of return for land treatment investment will be on rangeland with the average annual forage increase in yield estimated to be from 0.26 to 0.38 AUM's per acre.

National forest development and management opportunities and impacts

Development

The discussion of forest land development potential in chapter VII indicates that there is ample opportunity for accelerated development on National Forest land. The implicit assumptions underlying the identification of potentials and of problems and needs are that the region will continue to supply forest related goods and services at a rate equal to that of the immediate past. Because the timber industry has been responsive to the market, this is roughly analogous to the National Economic Development Objective described in the Water Resources Council Principles and Standards.

The opportunities for development to help meet projections of demand for timber, recreation at developed sites, forage, and fish and wildlife are shown in table VIII-3. Early action is an opportunity on the five potential small watersheds which include National Forest lands. Forest Service development can be accelerated in conjunction with PL 566 projects on these areas if sufficient additional funds such as Water Resource Development and Related Activity Program (WRDRA) money is provided. National forest development programs and projects could be accelerated to include almost all the remaining opportunity. Additional funds and manpower would be essential to convert these opportunities to reality.

Table VIII-2--Economic effects of land treatment alternatives on state and private land

Land Use and Treatment Practice	Area Needing Land Treatment	Projected Existing Programs			Proposed Accelerated Programs		
		Applied by year 2000	Installed cost	Annual forage Equiv. Incr. 1/	Applied by year 2000	Installed cost	Annual forage Equiv. Incr. 1/
	---acres---	---acres---	--dollars--	---AUMs---	---acres---	---dollars---	---AUMs---
Irrigated Cropland							
Irrigation and/or drainage systems	399,420	90,110		279,900	155,830		484,100
Cultural management measures	77,763	26,440		6,600	43,720		10,900
Water management measures	174,554	43,780		76,600	64,380		112,700
Subtotal	651,737	160,330	49,100,000	363,100	263,930	83,600,000	607,700
Nonirrigated Cropland							
Cultural or management measures	209,017	34,500	1,458,000	750	69,710	2,945,000	1,580
Range and Dry Pasture							
Planned grazing systems	3,794,638	836,820		83,650	1,963,540		196,400
Brush and weed control	973,405	137,360		23,410	321,020		53,720
Reseeding	29,933	7,840		3,970	19,580		9,840
Range renovation	14,975	890		450	1,890		900
Subtotal	4,812,951	982,910	4,000,000	111,480	2,306,030	9,725,000	260,860
Forested Land							
Forage improvement	194,340	68,840		6,910	114,990		11,530
Reduction of grazing	46,940	9,050		- 800	16,090		- 1,400
Subtotal	241,280	77,890	490,000	6,110	131,080	805,000	10,130
Other Lands							
Vegetative and structural measures	41,148	11,920	1,900,000	NA	26,870	4,325,000	NA
TOTAL	5,956,133	1,267,550	56,948,000	481,440	2,797,620	101,400,000	880,270

Price base 1974 costs. NA = Not Applicable.

1/ All crop and forage production converted to AUMs of forage equivalents (i.e. 450# corn or 900# hay = 1 AUM.)

Table VIII-3--Comparison of land treatment and structural measures planned and opportunities for an accelerated development alternative, Bighorn and Shoshone National Forests, Wyoming, and Custer and Gallatin National Forests, Montana, 1970

Project Item	Unit	Estimate Unit Cost	Currently Planned	Development Alternative Opportunities	
				Potential PL-566 action	Other long range action
		---dollars-----			
Range revegetation & plant control	acres	10-20	14,600	2,200	19,800
Range distribution trails	miles	200-600	160	3	127
Range fences	miles	2000-2500	388	30	277
Forest planting or seeding	acres	220	5,780	100	900
Forest Management:					
Insect control	acres	25-250	700	500	4,300
Disease control	acres	5-70	0	3,400	30,600
Release, harvest, thinning, weeding	acres	30-70	23,100	6,400	17,600
Fishing stream improvement	miles	200-2000	40	40	780
Fishing lake improvement	acres	3000-10,000	200	360	4,190
Waterfowl habitat management	acres	400-600	0	5	20
Fence key wildlife areas	miles	2,500-3000	10	NA	25
Trail construction & improvement	miles	5000-8000	1,440	45	360
Road construction & improvement	miles	35,000	1,560	47	315
Roadside observation sites	each	5000	10	5	33
Erosion control:					
Gullies	miles	2500-5000	5	1.5	119.5
Sheet erosion	acres	100-1000	0	5	4,095
Abandoned roads & trails	miles	500-1000	0	0.5	270
Stream bank stabilization	miles	200-2000	0	2	28
Mining control & restoration	acres	100-500	0	5	80
Sediment basin construction	ac.ft.	5000	0	0	5
Recreation:					
New site development					
Camping - picnicking	sites	2,500	0	0	146
Boat launch	sites	15,000	0	0	8
Winter sports[1]	sites	200,000	0	0	7
Wildlife habitat management	acres	15-50	1,500	NA	10,200

[1] Does not include private investment.

In order to more fully appraise the impact of Forest Service programs, an alternative set of assumptions and opportunities has been identified. The alternative is roughly analogous to an Environmental Quality Objective and is very consistent with a broad management direction which emphasizes key values such as dispersed recreation, wildlife, natural beauty, and watershed protection. Development is not an important feature of this alternative, and much of the forest area is reserved formally as Wilderness or by management direction as nondeveloped area.

There is good opportunity to emphasize the key values of this "non-development alternative." As previously mentioned, the basin contains 1,405,190 acres of National Forest land classified as either Wilderness or Primitive Area. In addition, there is about 864,000 acres of roadless area or about 38 percent of the Nonclassified National Forest land, which provides substantial opportunity for dispersed recreation, retention of natural and wild characteristics and similar experiences.

Impacts

Complete implementation of development opportunities would have significant positive impacts on future timber supplies, future minerals production, future recreation opportunity, future livestock production, and future wildlife numbers. Concurrently, some negative impacts would occur, notably in future opportunity for primitive and unconfined recreation and wilderness type experiences. Development could have some adverse impacts on landscape beauty, water quality, air quality, and the opportunity for special interest items such as scientific study.

Selection of the nondevelopment alternative would have significant negative effect on future production, especially of commodities such as timber and forage, and of opportunities for developed recreation such as camping, picnicking, summer homes, downhill skiing, and boating. Restrictions on access would eliminate motor vehicle use from many areas with a possible negative impact on grazing use, wildlife habitat development, wildlife harvest, mineral development, and the opportunity for structural water developments. Concurrently, some positive impacts would occur. These would be primarily related to opportunities for primitive and unconfined recreation, solitude, special interest studies, water quality, air quality, and natural landscape beauty.

Table VIII-4 compares some impacts of Development and Nondevelopment Alternatives. In addition, if the development alternative included installation of erosion control measures to the full extent indicated in table VIII-3, the following reductions in soil losses could be expected:

Measures	Annual soil loss reduction
	tons
Gully stabilization and control	38,700
Sheet erosion control	81,100
Stabilization of abandoned roads and trails	13,500
Streambank stabilization	9,300
Restoration and control of mining areas	30,000
Sediment basin construction	10,900
Forest planting and seeding	30,000

Table VIII-4 --Comparison of some impacts of Accelerated Development and Nondevelopment Alternative, National Forest land, Wind-Bighorn-Clarks Fork River Basin.

Use, service, or product	Unit	Amount Provided: Development Alternative	Amount Provided: Nondevelopment Alternative
Sawtimber and wood products	thousand board feet	108,000	27,500
Livestock capacity	thousand animal unit months	224.9	162.2
Developed recreation			
camping	thousand visitor days	2,152.5	1,338.4
picnicking	thousand visitor days	302.8	144.8
boating	thousand visitor days	96.25	21.25
winter sports	thousand visitor days	548.8	344.5
Water yield	ave. annual acre feet	4,333,000	4,323,000
Wildlife harvest			
hunting use	thousand visitor days	245	204.2
fishing use	thousand visitor days	1,195.4	1,167
Dispersed recreation use	thousand visitor days	1,492.8	1,079.2
Opportunity for primitive and unconfined recreation, solitude and special interests	qualitative	reduced on about 850,000 acres	No change
Natural landscape beauty	qualitative	reduced on some portions of area depending upon amount of new annual development	No change

State and private forest land development opportunities

There are many opportunities for accelerated development on the state and privately owned forest lands in the basin. There are about 217,000 acres of nonfederal forest land within the project areas of the identified potential small watershed projects which have some opportunity for accelerated forest land development. Existing cooperative forestry programs can be accelerated or initiated. Timber harvesting, timber stand cultural measures, insect and disease control, fire control, and reforestation are all measures which could be used to improve timber production from the basin's state and private forest lands. This increased timber can aid in counter-balancing the reduced timber output of the national forests and contribute to the projected demand for timber. Table VIII-5 lists estimated areas with opportunities for accelerated forest land treatment.

Opportunities for development and management of other public lands

The Bureau of Land Management administers the unreserved public lands which produce wildlife and fish habitat, timber and other wood products, water recreation, minerals, and grazing for livestock. The bureau has an active program of range and watershed improvement including brush control, contour terraces and furrows, fencing, seeding, waterspreading, detention dams, diversions, stockwater ponds, and spring developments. It also has an active program of recreation site selection and withdrawal. The lands are classified for retention in public ownership or disposal to either private individuals or other government agencies. Some of these lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes, and other lands have been transferred to the Bureau of Reclamation for the purpose of irrigation or electric power development.

USDA cooperation for resource development on private and federal rangelands in the basin is still in its beginning stages. This cooperation consists of coordinated ranch and allotment plans and working through conservation districts for both private and federal lands. All resources pertaining to the successful operation of a ranch are considered, particularly the crop and rangeland resources. When national forest lands are involved, a comprehensive plan involving these lands is considered.

Recent plan developments and on-the-ground application of these plans have resulted in much improvement of the lands involved. There is still a real opportunity for grazing improvement by improving stockwater supplies. Future operations will continue to conserve and develop the important public land resources.

RURAL RENEWAL OR RURAL DEVELOPMENT OPPORTUNITIES

Agriculture Secretary's Memorandum No. 1667 calls for recognizing that rural development is the primary responsibility of the local people. Within

Table VIII-5--Opportunity for accelerated land treatment and development on state and private forest lands

Item	Amount: Wyoming	Amount: Montana
	------acres------	
Timber surveys and plans	196,100	150,000
Timber management:		
Accelerated harvesting	108,100	
Thinning, release, weeding	40,000	44,000
Insect and disease control	500	
Tree planting and seeding	1,200	6,400
Fire prevention and control	58,700	150,000
Public Law 566 watershed assistance	75,000	142,100

Source: Correspondence with Wyoming State Forester and Wind River Indian Reservation Forester; U.S. Forest Service Surveys, Wyoming and Montana; Conservation Needs Inventory; Soil Conservation Service Watershed Investigation Reports; and Beartooth RC&D Report, Montana.

the basin the organization of the conservation districts, the RC&D project, and other local development groups is a fertile field for carrying out the purposes of the rural development program. Each county in the basin has organized rural development county committees to work with the state committee for rural development.

RURAL ELECTRIFICATION PROJECTS

There are several electric cooperatives within the basin. Major responsibilities of these cooperatives is to furnish low cost power for the rural people. At present these cooperatives distribute 380 million KWH to the rural users. There are opportunities to increase this amount.

OPPORTUNITIES FOR WILD, SCENIC, AND RECREATION RIVER AREAS

The Bureau of Outdoor Recreation, under the provision of Section 5(d) of Public Law 90-542, prepared a report on the Yellowstone River. According to the report, most of the Yellowstone River from Gardiner to Pompeys Pillar meets the criteria for scenic or recreational river areas.

A report of the Western U.S. Water Plan on critical water problems

of the 11 western states recommends designation of the Yellowstone River and the Clarks Fork for potential addition to the National Wild and Scenic River System (a Section 5(a) classification).

A bill to establish a state system of wild and scenic rivers was defeated in the 1974 session of the Montana Legislature. Most of the opposition came from farmers and ranchers concerned about access to the rivers for maintenance of existing diversions and construction of new diversions. Because of this opposition to a state system which would have included this reach of the Yellowstone River, Montana is withholding support of a 5(a) classification pending an indication of public support. Over 90 percent of the land bordering the Yellowstone River is privately owned. The local position will be determined through a series of public meetings in the basin.

There is some reason to doubt that the portion of the Yellowstone River bordering this river basin (from Columbus to Bighorn, Montana) possesses "...outstandingly remarkable scenic recreational, geologic, fish and wildlife, historic, cultural, or other similar values." 1/

The nation's need for energy and food will almost certainly require future development of the water of the Yellowstone River in the Billings area and downstream.

The Clarks Fork River originates in southern Montana near Cooke City. It meanders into Wyoming near Pilot and Index Peaks. For the first 20 miles the river flows at a moderate rate through a wide flood plain dotted with ranches and native hay meadows.

At the confluence with Crandall Creek the river drops, literally, into a 20 mile long primitive, scenic, and practically unnegotiable canyon. At the canyon mouth the river flows northward through small ranching communities and finally joins the Yellowstone River near Billings, Montana. Upstream from the canyon mouth the river is mostly in federal ownership--Shoshone National Forest in Wyoming and Gallatin National Forest in Montana. Downstream from the canyon mouth private ownership and public domain lands are intermingled.

The Clarks Fork River is free-flowing; and it traverses an area with unique scenic, recreational, geological, historical, archeological, fish, and wildlife values. The contrasting faces of the river from a placid, pastoral stream in the upper reaches to the awesome white water rapids, waterfalls, and deep pools in the canyon show little of man's influence. The population of the adjacent area is very small. The town of Cody, Wyoming, 36 miles away, is the largest population center. The Clarks Fork Road parallels about 11 miles of the canyon rim but never approaches closer than three-fourths of a mile. From the bridge near the Crandall Creek confluence to the Beartooth Highway the river is adjacent to the Clarks Fork Road. From the junction of the Beartooth Highway and the Clarks Fork Road to Cooke City, Montana, the river shares a broad valley bottom with U.S. Highway 212--the Beartooth Highway.

1/ See Public Law 90-542, paragraph (b).

The Clarks Fork River supports a thrifty fish population and provides high quality stream fishing. Most of the tributaries to the river are very productive also. Sunlight, Crandall, and Dead Indian Creeks are rated as very good trout waters with the fisheries of state-wide importance. The Clarks Fork itself is rated as important trout water with the fisheries of regional importance. Black bear, grizzly bear, mule deer, elk, mountain goat, various predators, waterfowl, upland gamebirds, eagles, falcons, and other game and nongame animals are abundant in the canyon and upper river valley.

The area's historical significance stems chiefly from the journey of the Nez Perce Indians under Chief Joseph. The entire band, including women and children, successfully eluded the U.S. Army by traveling down Dead Indian Creek, negotiating the face and sheer cliffs of the Clarks Fork Canyon. They emerged at the mouth of the canyon and escaped into central Montana.

There are several proposals for development which could affect the river. The Bureau of Land Management and Bureau of Reclamation have a power withdrawal along the length of the canyon portion. Two dam sites for hydroelectric power production have been proposed. One is in sec. 26, T. 56 N., R. 104 W., and the other is in sec. 10, T. 56 N., R. 105 W. Determination of which use--power production or wild and scenic river designation--has priority for this reach of the river will have to be made. A proposed all-weather highway is located in the canyon, but the location has been disapproved by State officials. The issue is quieted, but not dead, as future pressure may be mounted to construct the highway in the canyon if the river is not included in the National Wild and Scenic River System.

The Wind River above Boysen Reservoir has been identified by the Department of Agriculture for possible inclusion in the national system. However, existing reclamation and irrigation projects significantly affect the flow of water in this section of the river. The Wind-Bighorn River from Boysen Dam to the mouth of Wind River Canyon flows through an area which has particularly unique geologic and scenic values which may also make this reach eligible as a recreational river.

No proposal for USDA action in these reports would significantly adversely affect the designation of any part of the Yellowstone, Clarks Fork, or Wind River as a part of the National Wild and Scenic River System.

Other streams in the basin might also be studied for designation as a part of the system as follows:

Lake Fork Rock Creek above national forest boundary
West Fork Rock Creek above national forest boundary
East Rosebud Creek above Alpine
West Rosebud Creek above Mystic Lake
Forks of Stillwater River above national forest boundary
Wood River above its reservoir diversions
Greybull River above Pitchfork
North Fork Popo Agie above national forest boundary

Middle Popo Agie above national forest boundary
Medicine Lodge Creek above Hyattville
Paintrock Creek above Hyattville
Little Bighorn River above State Line
South Fork Shoshone River above Valley
North Fork Shoshone River above Buffalo Bill Reservoir
Tensleep Creek above Tensleep

Few of the streams listed above are well suited to recreational use for floating. The use of the Shoshone, Bighorn, and Yellowstone Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

IX. INTERAGENCY COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

The present and future needs of the people in the basin can best be met through the development and improved conservation of the basin's resources. Many of the needs of the people are identified and explained in Chapter III. The basic needs for improved resource conservation and development are explained in Chapter V. Estimates of the physical potential for the development of water and related land resources are found in Chapter VII. Agencies of the U.S. Department of Agriculture have several existing programs for managing the resources of national forest lands or assisting in the conservation and development of resources managed by private owners and local governments. Several specific opportunities for the development, conservation, or preservation of resources through existing and accelerated USDA programs are identified in Chapter VIII.

However, there are project and program opportunities and needs for resources development beyond the scope of existing USDA programs. Some of these opportunities can be developed without USDA action, but most can be enhanced if existing or enlarged USDA programs are included in interagency efforts. Changes in some of the existing programs, agency responsibilities, or new programs may be required to best meet some of the needs of the people for the resources of the basin. This chapter suggests some alternative approaches, describes some proposed developments and programs of other agencies, discusses the potential of using basin resources outside the basin, and discusses the need for expanded USDA programs.

ALTERNATIVE APPROACHES TO WATER AND RELATED LAND RESOURCE DEVELOPMENT

There are numerous approaches to the management or development of water and related land resources. For the purpose of this report the basic approaches are:

- Private development
- Local government programs
- State government programs
- Other federal agency programs
- Each of the above with USDA assistance
- USDA action

Each of these basic approaches will have variations based on economics, regulations, program or project options, conservation needs, and interagency relationships.

Private development

Private action in resource development will continue in response to opportunities to improve living standards and produce profits. This report contains useful information for individuals and businesses. General information about projected future demands, resource capabilities, resource problems, and resource limitations will be useful in making investment decisions. More specific information and technical assistance can be provided at local offices of USDA agencies.

Local government programs

Much that is said above can be stated for local government action. Public services also become a major consideration. The information in this report about projections of population, employment, recreation, and potential projects should be very useful to city and county governments.

State agency programs

The Water Resources Division of the Department of Natural Resources and Conservation in Montana and the Governor's Interdepartmental Water Conference and its represented agencies in Wyoming have responsibilities to coordinate various federal, state, and local water development projects. In the near future, federal financial assistance for construction in water and related land resource development for agricultural purposes may decrease. During the same time, federal technical assistance for planning will probably continue at about the present level while federal regulations for water quality and flow control will probably increase. Therefore, if early development is desired, other alternative approaches should be considered. The best near term opportunities appear to be suited to state projects and state assisted private developments.

There may also be a future bonus for increased state involvement. As national priorities change, more federal assistance may become available. Any actual increase in federal assistance will probably be based on a matching increase in state and private activity. Those states best organized for resource development will likely benefit most if federal assistance is increased.

Several RC&D project measures proposed in both states will need state assistance for completion. Both states are encouraged to expand their programs of technical and financial assistance programs in resource development.

Some of the USDA proposals for PL-566 watershed project type action face certain hurdles as federally assisted projects because of present laws and policies. Nevertheless, they offer excellent opportunity for development in a timeframe consistent with regional needs. Specific examples include: Midvale Watershed, where the primary opportunity is the irrigation of new land presently reserved by the Bureau of Reclamation; Cyclone Bar Watershed, where the project will irrigate pastureland not presently irrigated; and Gooseberry Creek, where there is an opportunity for inter-watershed transfer of water.

In addition to the watershed project type opportunities mentioned above, the two states have identified other potential projects for state action. For example, the Wyoming Water Planning Program in Wyoming has proposed three alternative projects involving a large reservoir on Clarks Fork. The proposals are to irrigate land in the Clarks Fork Basin or to supplement this development with irrigation of the Polecat Bench area and provide water for municipal and industrial uses.[1/]

1/ Water and Related Land Resources of the Bighorn River Basin, Wyoming, Wyoming Water Planning Program Report No. 11, October 1972.

Cooney Dam is an existing state project in Montana. The dam needs repair, but may have additional potential which should be considered before extensive repair work is done. Other existing water resource projects could also be repaired or improved through state action.

<u>Other federal agency programs</u>

Bureau of Land Management

The Bureau of Land Management administers more than one-fourth of the land in the basin. Action programs of the Bureau include:

a. Improved range management to bring 50 percent of the public range area to "good" range condition. Also, the area now rated as "poor" and "bad" is to be improved to "fair" condition. Forage under these improved conditions could increase by 208,000 animal unit months.

b. Range and forest fire and insect control.

c. Resource development through contour furrowing, seeding, and sage-brush control to reduce erosion while improving the range.

d. Forest management to improve timber yield.

e. Development of new camping and other recreational facilities and upgrading roads for access to public lands.

f. Minerals inventory and development.

g. Road construction.

h. Lands classification.

i. Cadastral surveying.

Any program for the public land which affects grazing use will affect agriculture in the basin. A reduction in forage taken from the public lands would require either a reduction in animal units in the basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland but would probably encourage an increase of animal units in the basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing land. USDA agencies can and should be actively involved in the development and coordination of such programs.

Bureau of Reclamation

The Bureau of Reclamation has been developing water storage, irrigation, and electric power projects since the beginning of the century. Existing reclamation projects in the basin were described briefly earlier in this report. There are no less than a dozen different proposals for new reclamation projects in the basin. Most are not large, and several involve extensions or enlargements of existing project facilities. In the near future, there may be more interest in developing hydroelectric power and industrial water than in irrigating new lands with federal projects. However, forage production in the basin could be increased through the development of new reclamation projects.

Corps of Engineers

Manderson, Wyoming, is periodically flooded from both Nowood Creek and the Bighorn River. The Corps has proposed a levee to provide protection from ice jams and floods. The project is feasible and may be developed when local residents are able to pay for the local share of the costs.

Bureau of Indian Affairs

The Bureau of Indian Affairs assists the Indian tribes in the basin with development of plans for new irrigation, improved agriculture, new industries, new recreational facilities, improved education programs, and numerous other projects under the trust responsibility of the federal government to Indian lands and tribes.

One of the most pressing legal questions involved in resource development in the basin concerns the water rights of the Indian tribes. A statement of the Bureau of Indian Affairs on this question is:

> In protection of Indian rights under the trust responsibilities, the Interior Department is now in the process of inventorying land and water uses for both present and future needs for all purposes. Confirmation will be accomplished by legislative, administrative, or court action.

The opportunity for USDA program assistance on Indian reservations will be severely restricted until this legal question is answered.

NEED FOR INTERAGENCY COORDINATION

Water, air, and land provide the life support system of the earth and are vital to every enterprise of man. The natural resources are interrelated so completely that every development of a resource affects other resources in some way. Because of this, it is impossible to create an agency for one kind of development or management which will not relate to the actions and duties of another agency. It is so with the agencies mentioned in this report. Therefore, interagency coordination is essential for orderly development of natural resources. Perhaps the most urgent need for interagency

coordination is in the development and exchange of technical information. There are also opportunities for joint action programs and projects.

USDA agencies can and do provide technical information about the use of natural resources to almost anyone who asks for it. One restriction does exist. Information that is confidential to an individual landowner or business may not be publicly disclosed without permission from that landowner or business. If the desired information is presently available, there is generally no charge for it. If new surveys are required, beyond the scope of existing programs and funds to obtain them, there may be a charge to help pay for the survey. State, private, and local government agencies should coordinate their planning efforts with USDA agency information and programs.

USDA agencies can provide a great deal of information about water and related land resources and the conservation use of these resources. Much of the general information available about the basin is included in this report. More detailed information is presently or can be made available about:

Soils
Irrigation management
Crop management
Range management
Forest management
Forest products
Wildlife needs
Pollution control in agriculture
Watershed hydrology
Farm and ranch economics
Watershed projects
Foundation geology
Ground water availability
Private and forest recreational potential
Drainage design
Annual streamflow forecasts
Conservation planning
Small project design
Other conservation needs

There should be continued and closer coordination between USDA agencies and the Bureau of Reclamation in reclamation project development and management. Soils information in project areas should be developed at the beginning of planning in a way which will not only provide the design information needed but serve the needs of the settlers for conservation planning. Reclamation projects can be more successful with an active assistance program in conservation farm planning of the kind provided by USDA agencies.

USDA and Bureau of Reclamation programs are often quite compatible and should be coordinated. The rehabilitation of existing irrigation systems and installation of drainage in reclamation project areas can be accomplished through programs of both agencies. Education and technical assistance for

improved irrigation water management is available for both programs. The RC&D committees could be very useful in providing leadership in coordinating activities by the two federal programs.

The Bureau of Reclamation, state agencies, and USDA agencies are interested in the management of precipitation or other weather modification. Individual agencies should not be allowed to pursue weather modification projects without interagency coordination.

Indian tribes have representatives on the RC&D committees. Activities on the reservations should be coordinated with other activities in the basin. Tribal councils should investigate the possibility of using more USDA programs and technical assistance to improve resource management practices on Indian lands.

Recently, a number of environmental agencies outside USDA have attained new prominence with legislated direction to regulate pollution, enhance fish and wildlife habitat, improve recreational facilities, and otherwise improve our natural environment. USDA agencies are working more closely with these agencies since policies require the preparation and review of environmental impact statements. The preparation and review of these statements can be a much easier process if agencies involved coordinate their efforts early in the planning stage. Other agencies should not overlook any opportunity to cooperate with USDA agencies. Each state has a clearinghouse agency which helps to coordinate state and federal planning and project efforts.

NEW USDA PROGRAMS OR CRITERIA TO MEET NEEDS

It is estimated that only 46 percent of the nonfederal lands will be adequately treated by the year 2000 if present programs are continued at the present level of technical assistance and financing. If we expect to meet additional conservation needs and the changing environmental and recreational demands, both new and accelerated programs will be required.

While detailed soil surveys are generally complete on presently irrigated land, they are usually not available for other land in the basin. Many projects and programs need basic soils data for proper planning and design. The need will become more pressing as environmental problems increase. The proper management and restoration of mined areas requires detailed knowledge of local soil characteristics. Proper management and treatment of rangelands, croplands, or timberlands must be based on such knowledge. The soil survey program for the basin should be accelerated.

Accelerated USDA programs are also needed for state and private forest lands. The existing cooperative fire management programs should be reinforced and extended to areas not now included. Timber production, watershed protection, and land use planning needs could be met by accelerating the cooperative forest management cooperative tree distribution, cooperative watershed, general forestry assistance, and tree planting and reforestation programs. Accelerated use of the advisory management program

to assist the State Foresters in managerial improvement, work measurment, work planning, and organization and management of programs would have beneficial effects on all forestry programs.

Acceleration of existing watershed management programs on the national forests would reduce erosion and sedimentation and help stabilize water runoff. Production of needed goods and services from national forest lands could be enhanced by acceleration of ongoing programs affecting resources such as recreation, wilderness, wildlife, livestock, and timber.

The Resource Conservation and Development Program has been conceived to expand the opportunities for conservation districts, local units of government, and individuals to improve their communities in multicounty areas. The Bighorn Basin RC&D Project has listed 82 project measures needed and possible in the Wyoming portion of the basin. Preliminary cost estimates for 52 of these projects amount to more than $80,000,000 just to construct. Under existing guidelines more than 50 percent of this cost is eligible for federal assistance. A major portion of this assistance qualifies under programs administered by USDA agencies. To date, however, this program has been limited by lack of funds and adequate personnel for proper administration. RC&D funds must be accelerated if these projects are to be completed in reasonable time.

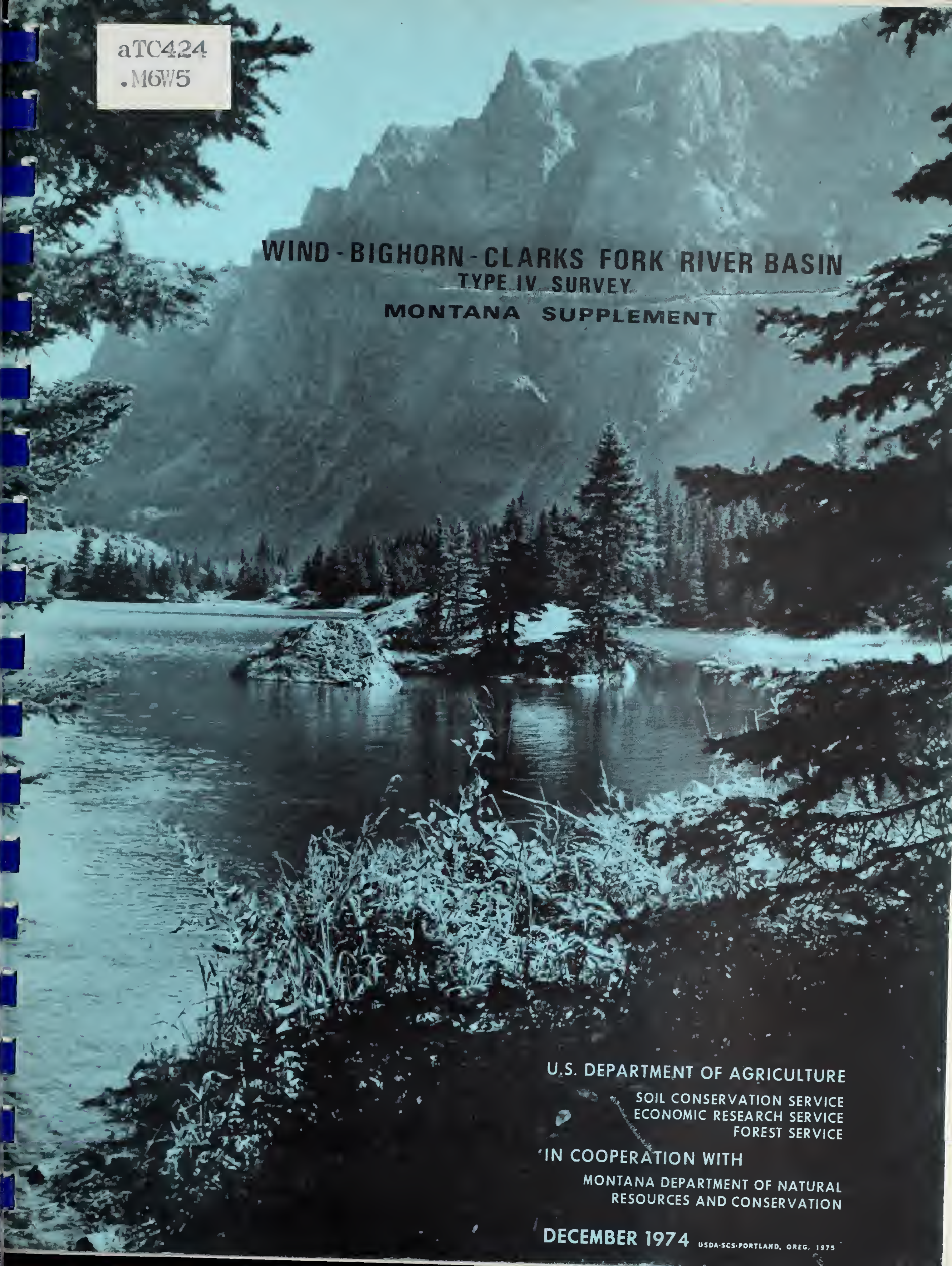
POTENTIAL USE OF WATER RESOURCES OUTSIDE THIS RIVER BASIN

The physical potential exists to transfer large amounts of water from this basin to other basins to the east. Projected needs for the Powder River Basin, in particular, far exceed its existing water supplies. There is potential conflict between existing and future needs within the basin and those outside the basin. The Bureau of Reclamation has performed a reconnaissance survey and given options for up to 640,000 acre-feet of water in the Wind-Bighorn River to be transported to points in eastern Montana and Wyoming for industrial purposes. One hundred and ten thousand acre-feet are to be used on the Crow Indian Reservation. One hundred and eighteen thousand acre-feet will be used in other areas in Montana, and the remainder are to be used in eastern Wyoming.

The 640,000 acre-feet is an estimate of the flow remaining after assumptions were made concerning depletions for proposed developments on the Wind River Indian Reservation, completion of the Hardin Bench Unit, Little Bighorn and Dunmore Units, the Riverton Project, and for projects of other agencies. Minimum flows for maintaining hydroplant capabilities and environmental requirements were also considered.

At present, the Yellowstone River Compact prohibits transfer. This compact may be renegotiated. The states involved will need to assign priorities and balance the use of water between the river basins.

aTC424
.M6W5



WIND - BIGHORN - CLARKS FORK RIVER BASIN

TYPE IV SURVEY

MONTANA SUPPLEMENT

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE

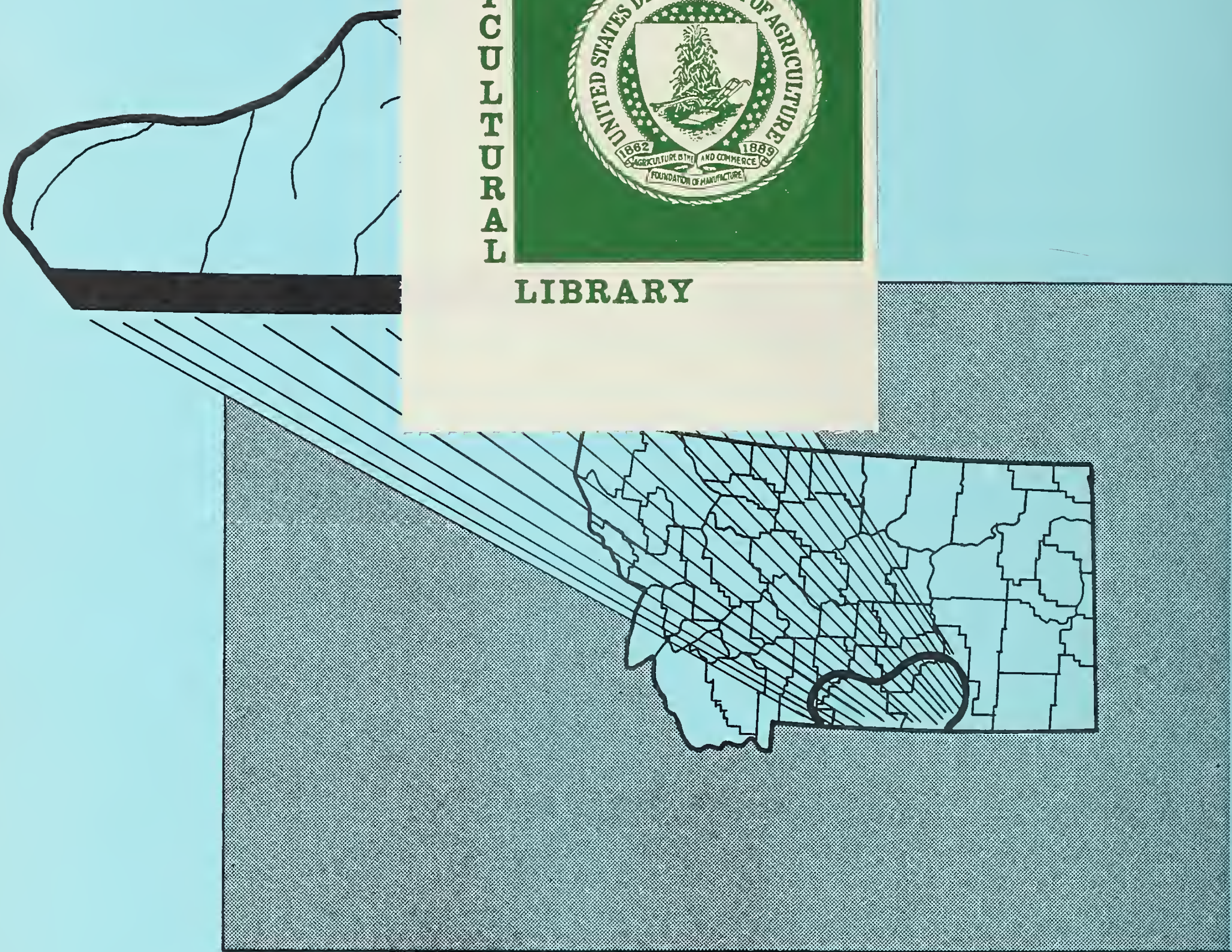
IN COOPERATION WITH

MONTANA DEPARTMENT OF NATURAL
RESOURCES AND CONSERVATION

DECEMBER 1974 USDA-SCS-PORTLAND, OREG. 1975

AD-33 Bookplate
(1-63)

NATIONAL
AGRICULTURAL
LIBRARY



Cover Photo: Elk Lake at the head of East Rosebud Creek in the Beartooth Primitive Area.
USDA-FOREST SERVICE PHOTO

ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN

TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5-5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

MONTANA SUPPLEMENT

to the

WIND-BIGHORN-CLARKS FORK RIVER BASIN REPORT

USDA WATER AND RELATED LAND RESOURCES REPORT

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

DECEMBER 1974

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JUN 27 1976
CATALOGING - PREP.

Bozeman, Montana

Under Direction of

USDA FIELD ADVISORY COMMITTEE

395344

WIND-BIGHORN-CLARKS FORK RIVER BASIN
MONTANA SUPPLEMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA MAPS, FIGURES, AND TABLES

FIGURES

TABLES

I. INTRODUCTION

This report presents data on water and related land resources in the Montana portion of the Wind-Bighorn-Clarks Fork River Basin (hereafter referred to as Basin). Basin area includes the Bighorn and Clarks Fork River drainages and all of the south-bank drainages of the Yellowstone River from and including the Little Bighorn and Tullock Creek on the east through the Stillwater River on the west. Most of the water inventoried in this study enters Montana from Wyoming in the Bighorn and Clarks Fork Rivers. Total area in the overall Basin is 18,167,993 acres, including 13,179,045 acres in Wyoming and 4,988,948 acres in Montana. The Basin area in Montana includes all of Carbon County, most of Big Horn County, and parts of Stillwater, Yellowstone, Sweet Grass, Park, and Treasure Counties.

The purpose of this study is to outline a coordinated and orderly program for the conservation, development, utilization, and management of the water and related land resources of the Basin. Data presented here will be helpful in administration of the Yellowstone River Compact, development of the Montana State Water Plan, and assisting state and local agencies in developing optimum use of the Basin's natural resources. The report provides the U. S. Department of Agriculture with information it needs for resource development under various on-going programs and will be useful toward implementation of new USDA programs. Data for multiple use planning and resource management are included on outdoor recreation, conservation district programs, Conservation Operations, Great Plains Conservation, Watershed Investigation and Planning, general and detailed installation services for structural conservation measures, land treatment under Agricultural Stabilization and Conservation Service programs, Resource Conservation and Development project measures, National Forest management programs, state-federal forestry programs, and rural electrification projects.

Participation of the U. S. Department of Agriculture was authorized under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566), 83d Congress, as amended and supplemented. This Act authorizes the Department to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds and rivers as a basis for development of coordinated programs. Participation of the Montana Department of Natural Resources and Conservation is authorized under Title 89, chapters 1 and 35, Revised Codes of Montana, 1947.

Data were developed by field technicians of the Forest Service, Economic Research Service, and Soil Conservation Service, with additional data interpreted from secondary sources. Particular emphasis was placed on field investigation of potential PL-566 projects and multiple use development opportunities. In addition, acknowledgement is given for data provided by other agencies. At the local level,

individuals and officials of counties, municipalities, conservation districts, irrigation companies, and newspapers also provided assistance. State agencies included Montana Department of Natural Resources and Conservation as sponsor, Fish and Game Department, Department of Health and Environmental Sciences, Department of State Lands, Division of Planning and Economic Development, and Bureau of Mines and Geology. Other USDA agencies included Agricultural Stabilization and Conservation Service, Montana Cooperative Extension Service, Farmers Home Administration, Statistical Reporting Service, and Rural Electrification Administration. U. S. Department of the Interior agencies included Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, Geological Survey, U. S. Fish and Wildlife Service, and National Park Service. Other federal agencies supplying data included the Department of Commerce and Bureau of Public Roads.

II. NATURAL RESOURCES OF THE BASIN

LOCATION AND SIZE

The Wind-Bighorn-Clarks Fork River Basin lies in northcentral Wyoming and southcentral Montana. The Montana portion is just northeast of Yellowstone Park and contains all Carbon County, 72 percent Big Horn County, 40 percent Stillwater County, 39 percent Yellowstone County, 7 percent Sweet Grass County, 4 percent Park County, and 13 percent Treasure County. See map II-1. The Basin area in Montana approximates 7,795 square miles. See table II-1 and table II-2.

CLIMATE

The Basin climate in Montana varies from humid alpine above 12,000 feet in elevation with over 70 inches annual precipitation to arid around 4,000 feet near Belfry, Montana, with less than six inches annual precipitation. As a result, Basin vegetation varies from alpine tundra through conifer forests to desert shrub. A more comprehensive orientation is shown on map II-2. Growing seasons are more closely related to elevation than to latitude. Based on 28-degree minimum temperature, the mean growing season at Red Lodge is 134 days at an elevation of 5,762 feet compared with 154 days at Bridger at an elevation of 3,720 feet, and 163 days near Billings.

Daily average temperatures during the June-September recreational period range from 54°F. to 81°F. at Billings with a long-term average of 63°F. October-November hunting season temperatures vary from 24° to 54° with an average of 43°. At Red Lodge the June-September range is 42° to 71° with an average of 59°. October-November range is 21° to 51° with an average of 39°. December-January temperatures range from 2° to 36° with an average of 24° during the skiing season. Summer days at lower elevations are often hot, yet nights cool off to the extent that blankets are needed for sleeping. Big game season daytime temperatures in the shade are cool enough to keep the meat from spoiling and cold enough at night to require heated tents or campers. At the upper elevations, frost and snow can occur any night of the year.

PHYSIOGRAPHY AND GEOLOGY

Topographic features of the Basin have an extreme range from the flat valley bottoms of the Bighorn and Clarks Fork Rivers with around 3,000 feet elevation to the high mountainous plateaus and craggy peaks of the Beartooth and Absaroka Mountains with elevations up to 12,799 feet. The Pryor Mountains, with less spectacular yet scenic peaks of up to 8,786 feet elevation, separate the two principal rivers. Along the southeast end of the Pryors lies the deeply incised Bighorn Canyon which now holds the waters of Bighorn Lake. This magnificent canyon was relatively inaccessible before the construction of Yellowtail Dam.

TABLE II-1--SURFACE OWNERSHIP AND ADMINISTRATION BY COUNTY 1/
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County & Unit	County Total	Indian Trust Lands	Other Private	State Fish & Game	Other State	National Forest	Bureau of Land Management	Bureau of Reclamation	Other Federal Agencies	Percent of County in Basin
Big Horn										
Acres	2,325,740	1,330,639	937,572	316	45,632	---	---	10,921	660	
Percent	100	57.2	40.3	---	2.0			0.5	---	72
Carbon										
Acres	1,324,800	---	721,410	340	44,081	330,578	205,218	---	23,173	
Percent	100		54.4	---	3.3	25.0	15.5		1.7	100
Park										
Acres	69,050	---	3,635	---	---	65,415	---	---	---	
Percent	100		5.3			94.7				4
Stillwater										
Acres	462,024	---	259,722	515	7,443	188,544	5,800	---	---	
Percent	100		56.2	0.1	1.6	40.8	1.3			40
Sweet Grass										
Acres	77,049	---	2,079	---	320	74,650	---	---	---	
Percent	100		2.7		0.4	96.9				7
Treasure										
Acres	79,312	---	75,792	---	3,520	---	---	---	---	
Percent	100		95.6		4.4					13
Yellowstone										
Acres	650,973	134,163	491,314	---	21,481	---	4,015	---	---	
Percent	100	20.6	75.5		3.3		0.6			39
TOTALS										
Acres	4,988,948	1,464,802	2,491,524	1,171	122,477	659,187	215,033	10,921	23,833	XXX
Percent	100	29.6	49.9	---	2.4	13.2	4.3	0.2	0.4	XXX

1/ Includes Water Area.

MAP II-1

PROJECT MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA AND WYOMING

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

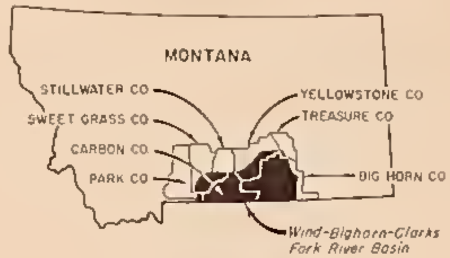
USDA-SCS-PORTLAND OREG 1973

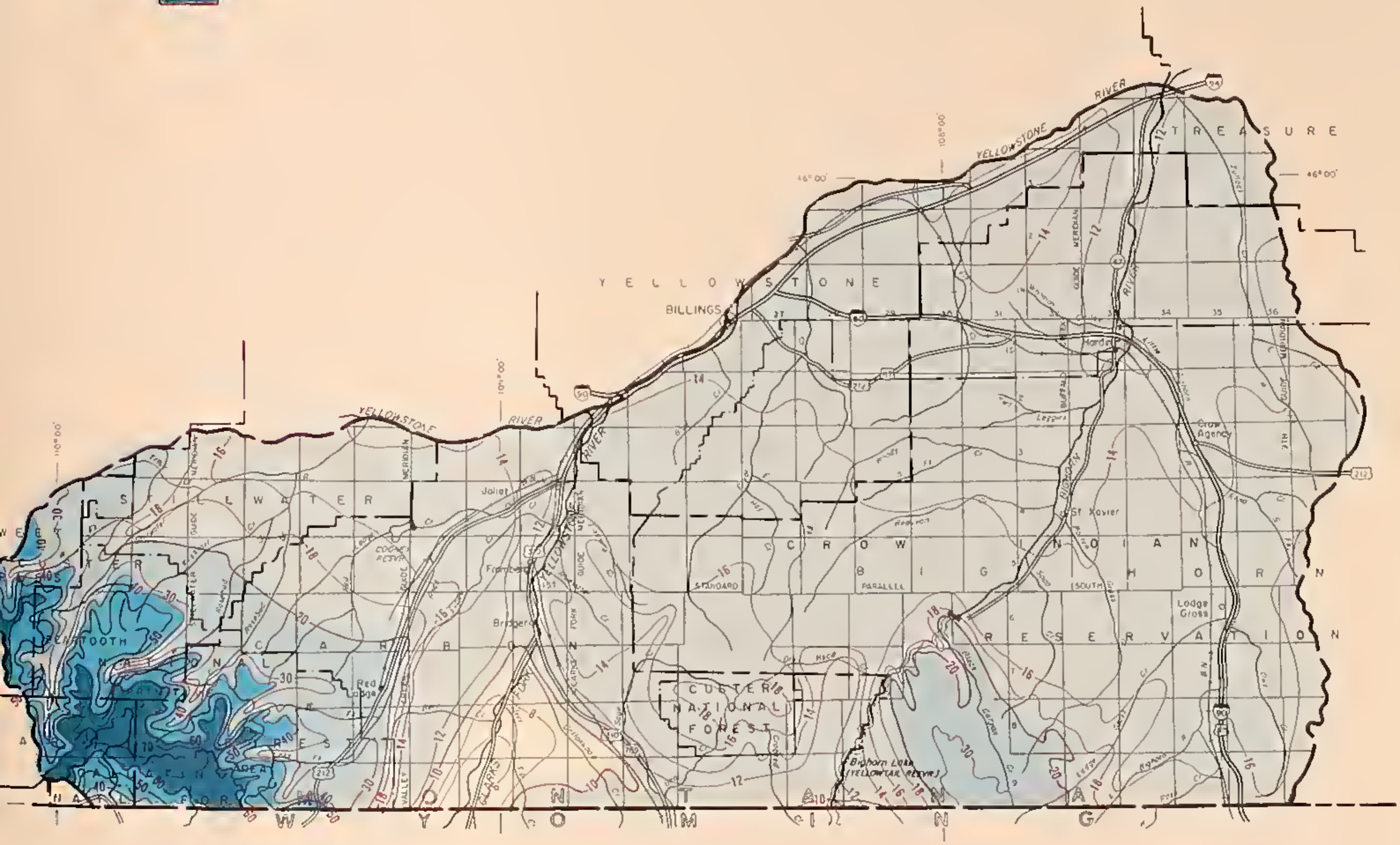
M7-0-22915-L

LEGEND

Average Annual Precipitation

- 0 to 10 inches
- 10 to 20 inches
- 20 to 40 inches
- 40 to 60 inches
- Over 60 inches





MAP II-2

AVERAGE ANNUAL PRECIPITATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914 A-N

Many more miles of the Canyon's sandstone and limestone cliffs can now be viewed from the comfort of a boat.

The rugged high elevation plateaus southwest of Red Lodge are above timberline and consist of rocky peaks, alpine meadows, and

TABLE II-2--AREAS OF RIVER BASIN BY SUBBASIN
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Area (acres)
Stillwater	676,681
Yellowstone Minor Drainages	935,209
Clarks Fork	976,328
Big Horn	1,763,009
Little Bighorn	637,721
Montana TOTAL	4,988,948

Source: River Basin Planning Staff

basins carved by recent glaciers. Most of the scenic wild beauty of this high country's lakes and remnant glaciers is accessible only by trails. Much of the roadless area has been designated as Primitive Area and is under study by the Forest Service for Wilderness classification. The car-bound tourist is afforded a partial glimpse of this "Big Sky" wonderland as he travels the spectacular route to Yellowstone Park over the Beartooth highway between Red Lodge and Cooke City.

Melting snows and glaciers of the Basin high country feed hundreds of lakes and the streams and rivers. Streams generally flow north and east to join the Yellowstone River which eventually becomes part of the flows of the Missouri and Mississippi Rivers. The Stillwater River enters the Yellowstone River near Columbus, the Clarks Fork River enters near Laurel, and the Bighorn River enters the Yellowstone near the old settlement of Big Horn just east of Custer,

Montana. The larger lakes of the area are either man-made or have been enlarged by man. They include Bighorn Lake, Mystic Lake, Cooney Reservoir, and Willow Creek Reservoir near Lodge Grass.

The geologic history of the Basin is a complex record of sedimentation, uplift, igneous intrusion, folding, faulting, and erosion. In the Montana portion of the Basin, at least 30 separate geologic formations, ranging in age from Precambrian to Tertiary, have been identified. The formations are mostly sandstone, shale, and limestone. Some ancient schist, gneiss, and metamorphosed granitic rocks are present in an uplifted block constituting the Beartooth Plateau. There are exposures of intrusive and extrusive igneous rocks; the layered igneous ultrabasic rocks of the Stillwater Complex extend southeast along the plateau front from the West Fork Stillwater River to Fishtail Creek, and smaller intrusive dikes and sills are emplaced within and across older volcanic and sedimentary rocks.

MINERAL RESOURCES

Several mineral commodities have been developed in the Beartooth and Pryor Mountains regions, and deposits of fossil fuels within the Basin are significant. The more important mineral resources include bentonite, coal, gypsum, chromite, copper and nickel, clay, uranium, oil and gas, limestone, and sandstone. Most of these commodities, however, are not in current production.

a. Bentonite--deposits of bentonite are extensive in Upper Cretaceous strata east of the Clarks Fork River.

b. Coal--eight significant coal seams are present in the Red Lodge field, and three discontinuous seams are present in the Bridger field. Both fields are in Carbon County. Coal seams of the Red Lodge field are in the Fort Union Formation of Paleocene age, are of good quality, and are classed as high subbituminous to low bituminous. The beds are 3-1/2 to 10 feet thick and all eight have been mined. Coal seams of the Bridger field are in the Eagle Sandstone, of upper Cretaceous age, are of medium quality, low bituminous in rank, and range from 2-1/2 to 6 feet thick. Underground mining has been successful in both the Red Lodge and Bridger fields, and coal has also been produced from the Silvertip and Stillwater coal deposits in Carbon and Stillwater Counties.

Production of coal in the western Bighorn Basin in the near future is unlikely because of higher costs of underground mining as compared to production costs from the large surface-mineable coal fields in Big Horn, Rosebud, and Powder River Counties to the east of the study area. Cost of mine-mouth coal from underground mining is about four times that of mine-mouth coal produced by a large surface mine. Surface mining

of coal from the deep-lying seams in Carbon County does not seem practical, which leads to the conclusion that coal production in the study area is unlikely.

c. Gypsum--the Chugwater Formation, of Triassic age, contains gypsum deposits of good quality near Bridger. This formation crops out extensively in the East Pryor Mountains, and gypsum is reported at different levels.

d. Chromite--deposits of low-grade (low chromium-iron ratio) chromite in the Stillwater Complex of southern Stillwater County are very large. These deposits were mined during the emergency period of World War II and for a few years thereafter. At present, however, Montana chromite cannot compete with higher-grade foreign ore.

e. Copper and Nickel--a large, low-grade deposit of copper-nickel-chromite containing platinum as an accessory mineral occurs in the Stillwater drainage (Stillwater Complex) south of Nye. Core drilling in 1969 disclosed sufficient reserves to justify additional work and probable future production.

f. Clay--good quality clay was used in brick manufacture at Fromberg. This clay and other deposits in the Fort Union Formation are known to be of suitable quality for brickmaking.

g. Uranium--the upper part of the Madison Limestone, of Mississippian age, near the Madison-Amsden contact on East Pryor Mountain and on upper Hough Creek southwest of Pryor, contains uranium minerals. The uranium deposits are in caverns and sinkholes in the limestone, and are of good grade, but small size. Fluorite is associated with the uranium, but the deposits are not known to be commercial.

h. Oil and Gas--oil and gas resources in the northern part of the Bighorn Basin are not extensive, but both are being produced. The Elk Basin area along the Montana-Wyoming border is in full production; the Hardin field in Big Horn County is less active. Sulfur is produced as a by-product in the Elk Basin field. Dry Creek Basin in Carbon County has potential for development of both oil and gas.

i. Limestone--the Madison Formation near Warren provides limestone principally for sugar refining. Some limestone is cut for building stone.

j. Sandstone--sandstone was formerly quarried from the Lennep Formation near Columbus. As interest in building stone increases, this resource may come back into use.

The U. S. Geological Survey and the U. S. Bureau of Mines are investigating the mineral resources of the Beartooth Primitive Area prior to a determination as to whether this area should be included in the Wilderness System. A Wilderness Area designation would exclude development of mining claims after 1983.

Rocks exposed in the Basin range in age from Quaternary to some of the oldest Precambrian rocks in Montana. The young Quaternary material is unconsolidated water-laid alluvium and colluvium. Rocks here represent every geologic period except the Silurian. Except for igneous and metamorphic rocks in the Beartooth Mountains, they are predominantly sedimentary types deposited in both continental and marine environments on a constantly changing earth. Precambrian metamorphic rocks in the Beartooth Mountain areas are crystalline types formed by heat and pressure probably over 1,000 million years ago and also underlie sedimentary rocks in the remainder of the Basin.

Tectonic movements of the earth's crust have occurred here since the beginning of geologic time. The greatest changes have been in the mountainous areas. Structural trends are believed related to patterns established in Precambrian time, but were largely rejuvenated during the early Tertiary period, about 65 million years ago. Large-scale thrust-faulting and folding took place at this time and resulted in the present basin-and-range tectonic pattern typical of the middle Rocky Mountain region.

The greatest tectonic movement took place in the Beartooth, Pryor, and Bighorn Mountain areas where an excess of four miles of vertical uplift has taken place since Cambrian time. The Flathead Sandstone of Cambrian age lies on metamorphic rocks on the Beartooth Plateau at an elevation of 12,000 feet, while north of the Beartooth Overthrust near Red Lodge, this formation is 10,000 feet below sea level. Relatively young Wasatch and Fort Union Formations, 40-65 million years of age, outcrop on the north side of the fault.

Other prominent structures in and adjacent to the Basin have undergone less movement, but are important geologic features. Vertical movement has taken place along the Nye-Bowler Lineament, the Fromberg Fault Zone, the Lake Basin Fault Zone, the Reed Point Syncline, the Ashland Syncline, and the Powder River Basin. These crystal changes have developed anticlines, synclines, and faults that affect mineral, water, and other resources.

Over 47 miles of magnificent canyons can now be viewed from the comfort of a boat on Bighorn Lake. Most of this area was accessible only by foot prior to construction of Yellowtail Dam.
BUREAU OF RECLAMATION PHOTO

The graceful arch of Yellowtail Dam rises 525 feet from the Bighorn River bed.
BUREAU OF RECLAMATION PHOTO

Boat launching ramp at mile 47 on Horseshoe Bend of Bighorn Lake is readily accessible from U. S. Highway 14A near Lovell, Wyoming.
BUREAU OF RECLAMATION PHOTO

PLATE 2

Above: Herefords grazing in an open park in Custer National Forest. USDA-FOREST SERVICE PHOTO

SCS PHOTO 11-P569-2

Stockwater ponds and spring developments are a necessity in managing range use in the arid and semi-arid parts of the Basin.

SCS PHOTO 11-P196-10

PLATE 3

Glacial deposits of Pleistocene age and terraces are prominent along some of the larger drainages. Glaciation occurred primarily in the Beartooth Mountains and adjacent areas. Several levels of stream terraces, underlain by sand and gravel deposits, occur along most of the major streams; development is best, however, near the mountains. Unconsolidated alluvium occurs in the flood plains of all streams, valuable in many locations for obtaining ground water.

LAND RESOURCES

Soils

The influences of climate, vegetation, and topography on parent materials are apparent in the soils of the area. Cropland soils in the Basin were classified into 19 soil productivity divisions for projecting development and production potential and for correlation with current production. These productivity divisions consist of groups of similar land capability units as contained in the Conservation Needs Inventory. By recalling data on their present use and production and conservation treatment needed, it is possible to project some degree of change in production from accomplishing those treatment practices. These changes are shown in chapter VIII. A generalized physical description of basin soils is presented on map II-3.

Land Ownership and Administration

The ownership pattern in the Basin has had considerable effect on the resource development. Ownership and administration of land includes 49.94 percent private non-Indian, 29.36 percent Indian Trust, 2.46 percent State of Montana, 0.02 percent Montana Fish and Game, 13.21 percent National Forest, 4.31 percent Bureau of Land Management, 0.22 percent Bureau of Reclamation, and 0.48 percent Other Federal. See Land Ownership Map II-4 and tables II-1 and II-3.

Vegetative Cover and Land Use

About 66 percent of the 7,795 square miles of the Basin in Montana is dominated by grass cover. Grass is an exceptionally important commodity as it supports large numbers of livestock which contribute more to agricultural income than any other product. Because of climatic, topographic, or other limitations, federal lands are used predominantly for grazing, forestry, fish and wildlife production, recreation, and mining. Livestock use on National Forest lands provides 15,000 animal unit months (AUM's) of summer forage on 48,850 acres. The Bureau of Land Management obtains 29,000 AUM's of use from 215,000 acres at lower elevations. Indian lands totaling 1,120,000 acres are grazed to yield 312,000 AUM's of use during the year. The remaining 1,788,000 acres of private range yield about 445,000 AUM's of grazing. Total yield of range in the Basin is estimated at 801,000 AUM's.

TABLE II-3--LAND SURFACE OWNERSHIP AND ADMINISTRATION BY WATERSHEDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Acres in Watershed	Private 1/	State	Fish & Game	National Forest	Bureau of Land Mgmt.	Indian Trust	Bureau of Reclamation	Other Fed. Agencies
		acres								
	Stillwater Subbasin									
14b-1	Upper Stillwater River	213,460	16,354	436	---	196,510	160	---	---	---
14b-2	Fishtail to Butcher Cr.	258,165	103,920	3,449	---	148,974	1,822	---	---	---
14b-3	Lower Stillwater River	123,120	95,900	2,926	494	20,500	3,300	---	---	---
14b-4	Shane-Beaver Cr.	81,936	79,153	2,092	21	---	670	---	---	---
	Subbasin Total	676,681	295,327	8,903	515	365,984	5,952	---	---	---
	Yellowstone Minor Drainages									
14-22	Cow-Bellion Cr.	63,436	60,372	1,790	---	---	1,274	---	---	---
14-27	Blue-Duck Cr.	118,570	111,915	4,469	---	---	1,920	266	---	---
14-31	Arrow Cr.	72,869	69,506	3,323	---	---	40	---	---	---
14-32	Fly Cr.	179,151	149,757	5,600	---	---	130	23,664	---	---
14-36	Lost Boy Cr.	90,339	84,794	5,400	---	---	145	---	---	---
14-37	Custer Drainage	21,422	20,502	920	---	---	---	---	---	---
14d-1	Upper Pryor Cr.	220,202	59,483	499	195	---	---	160,025	---	---
14d-2	Lower Pryor Cr.	169,220	111,933	3,600	---	---	620	53,067	---	---
	Subbasin Total	935,209	668,262	25,601	195	---	4,129	237,022	---	---
	Clarks Fork Subbasin									
14c-3	Clarks Fork-Zimmer Cr.	73,865	2,420	---	---	71,445	---	---	---	---
14c-4	Pat O'Hara Cr.	797	797	---	---	---	---	---	---	---
14c-4a	Big Sand Coulee	13,352	4,118	840	---	---	8,394	---	---	---
14c-5	Line Cr.	11,957	240	---	---	11,577	140	---	---	---
14c-6	N.F. Cherry-Silvertip Cr.	153,942	67,081	7,651	---	---	79,210	---	---	---
14c-7	Clarks Fork-Ruby Cr.	169,220	127,924	7,288	---	5,124	28,884	---	---	---
14c-8	Upper Rock Cr.	120,929	7,192	752	---	112,825	160	---	---	---
14c-9	Red Lodge-Rock Cr.	207,780	178,269	10,292	250	18,276	693	---	---	---
14c-1C	Elbow-Lower Rock Cr.	91,302	88,402	2,541	---	---	359	---	---	---
14c-11	Lower Clarks Fork, E.Side	133,184	111,346	6,296	90	---	9,104	6,348	---	---
	Subbasin Total	976,328	587,789	35,660	340	219,247	126,944	6,348	---	---

See footnote on following page.

TABLE II-3--LAND SURFACE OWNERSHIP AND ADMINISTRATION BY WATERSHEDS (Cont'd)

Watershed Number	Watershed Name	Acres in Watershed	Private 1/	State	Fish & Game	National Forest	Bureau of Land Mgmt.	Indian Trust	Bureau of Reclamation	Other Fed. Agencies
	Bighorn Subbasin	- - - - - - - -	- - - - - - - -	- - - - - -	- - - -	a c r e s	- - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - -
14e6-8	Sage Cr.	150,687	44,862	3,780	---	41,348	28,876	31,821	---	---
14e6-8a	Dry Cr.	9,233	---	731	---	---	8,502	---	---	---
14e-27	Crooked Cr.	63,869	1,011	1,840	---	23,705	36,593	---	---	720
14e-28	Porcupine Cr.	19,031	---	---	---	---	---	18,325	706	---
14e-30	Dryhead Cr. to Wyo.	112,625	42,064	2,180	---	8,903	3,917	32,283	825	22,453
14e-31	Black Canyon Cr.	146,037	---	---	---	---	---	140,037	6,000	---
14e-32	Soap Cr.	112,493	29,709	1,080	---	---	---	80,294	1,410	---
14e-33	Beauvais Cr.	211,168	59,615	4,938	---	---	---	144,635	1,980	---
14e-34	Rotten Grass Cr.	166,629	47,521	1,819	121	---	---	117,168	---	---
14e-35	Two Leggins-Woody Cr.	163,807	38,361	5,968	---	---	---	119,478	---	---
14e-36	Warren Bench	6,808	2,229	---	---	---	---	4,579	---	---
14e-37	West Side Bighorn River	152,414	146,718	5,520	---	---	120	56	---	---
14e-37a	Two Leggins Irr. Unit	32,781	30,056	369	---	---	---	2,356	---	---
14e-38	East Side Bighorn River	117,308	94,144	5,865	---	---	---	17,299	---	---
14e-39	Upper Tullock Cr.	137,867	25,226	2,280	---	---	---	110,361	---	---
14e-40	Lower Tullock Cr.	160,252	150,985	8,506	---	---	---	761	---	---
	Subbasin Total	1,763,009	712,501	44,876	121	73,956	78,008	819,453	10,921	23,173
	Little Bighorn Subbasin									
14e7-1	Little Bighorn River	88,346	39,082	2,800	---	---	---	46,464	---	---
14e7-2	Pass Cr.	14,348	8,632	---	---	---	---	5,716	---	---
14e7-3	Lodge Grass Cr.	108,938	25,797	2,589	---	---	---	80,552	---	---
14e7-4	Owl Cr.	158,559	64,140	29	---	---	---	94,390	---	---
14e7-5	Little Bighorn E. Side	141,321	43,691	1,920	---	---	---	95,050	---	660
14e7-6	Little Bighorn W. Side	126,209	46,303	99	---	---	---	79,807	---	---
	Subbasin Total	637,721	227,645	7,437	---	---	---	401,979	---	660
	Summary									
Stillwater Basin		676,681	295,327	8,903	515	365,984	5,952	---	---	---
Yellowstone Minor Drainages		935,209	668,262	25,601	195	---	4,129	237,022	---	---
Clarks Fork Subbasin		976,328	587,789	35,660	340	219,247	126,944	6,348	---	---
Bighorn Subbasin		1,763,009	712,501	44,876	121	73,956	78,008	819,453	10,921	23,173
Little Bighorn Subbasin		637,721	227,645	7,437	---	---	---	401,979	---	660
TOTAL		4,988,948	2,491,524	122,477	1,171	659,187	215,033	1,464,802	10,921	23,833

1/ Does not include Indian Trust lands.

Source: River Basin Planning Staff and land administration agencies.

TABLE II-4--VEGETATIVE ASPECT AND LAND USE BY WATERSHEDS
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Grass	Dry Cropland	Irr. Cropland	Trees	Brush	Alpine & Barren	Urban & Builtup	Water	Total Acres
		- - - - - - -	- - - - - - -	- - - - - - acres	- - - - - - -	- - - -	- - - - -	- - - - -	- - - -	- - - - -
	Stillwater Subbasin									
14b-1	Upper Stillwater River	91,042	15	768	113,303	--	6,700	361	1,271	213,460
14b-2	Fishtail to Butcher Cr.	127,447	3,330	18,843	77,451	--	27,000	1,918	2,176	258,165
14b-3	Lower Stillwater River	97,160	3,321	5,490	15,692	--	--	1,191	266	123,120
14b-4	Shane-Beaver Cr.	57,695	13,149	4,151	5,632	--	--	1,064	245	81,936
	Subbasin Total	373,344	19,815	29,252	212,078	--	33,700	4,534	3,958	676,681
	Yellowstone Minor Drainages									
14-22	Cow-Bellion Cr.	25,236	14,248	1,610	21,330	--	--	637	375	63,436
14-27	Blue-Duck Cr.	87,350	24,967	3,124	250	--	--	2,193	686	118,570
14-31	Arrow Cr.	37,852	1,269	27,990	2,600	--	--	3,009	149	72,869
14-32	Fly Cr.	132,987	17,026	1,250	26,230	--	--	1,577	81	179,151
14-36	Lost Boy Cr.	62,915	3,533	1,058	21,700	--	--	1,043	90	90,339
14-37	Custer Drainage	14,592	1,076	2,200	2,780	--	--	590	184	21,422
14d-1	Upper Pryor Cr.	171,819	26,921	1,371	19,140	--	--	723	228	220,202
14d-2	Lower Pryor Cr.	135,598	14,588	1,348	16,230	--	--	1,224	232	169,220
	Subbasin Total	668,349	103,628	39,951	110,260	--	--	10,996	2,025	935,209
	Clarks Fork Subbasin									
14c-3	Clarks Fork-Zimmer Cr.	1,328	--	--	29,000	--	37,593	72	5,872	73,865
14c-4	Pat O'Hara Cr.	449	215	112	--	--	--	9	12	797
14c-4a	Big Sand Coulee	917	741	968	--	10,462	--	122	142	13,352
14c-5	Line Cr.	3,459	--	--	5,900	2,292	299	--	7	11,957
14c-6	N.F. Cherry-Silvertip Cr.	21,596	2,232	10,633	5,850	111,994	--	1,487	150	153,942
14c-7	Clarks Fork-Ruby Cr.	96,991	4,124	11,385	7,660	47,229	--	1,511	320	169,220
14c-8	Upper Rock Cr.	69,315	652	40	32,413	--	16,948	684	877	120,929
14c-9	Red Lodge-Rock Cr.	119,076	27,464	39,308	16,570	--	--	3,897	1,465	207,780
14c-10	Elbow-Lower Rock Cr.	44,318	20,865	19,100	3,770	--	--	2,849	400	91,302
14c-11	Lower Clarks Fork E. Side	102,064	19,199	7,082	3,842	--	--	711	286	133,184
	Subbasin Total	459,513	75,492	88,628	105,005	171,977	54,840	11,342	9,531	976,328

TABLE II-4--VEGETATIVE ASPECT & LAND USE BY WATERSHEDS (Cont'd)

Watershed Number	Watershed Name	Grass	Dry Cropland	Irr. Cropland	Trees	Brush	Alpine & Barren	Urban & Builtup	Water	Total Acres
		acres								
	Bighorn Subbasin									
14e6-8	Sage Cr.	83,539	1,171	1,449	47,120	16,540	--	686	182	150,687
14e6-8a	Dry Cr.	5,918	--	--	--	3,288	--	27	--	9,233
14e-27	Crooked Cr.	31,870	--	332	27,200	4,384	--	63	20	63,869
14e-28	Porcupine Cr.	4,491	--	--	3,031	10,960	199	--	350	19,031
14e-30	Dryhead Cr. to Wyo.	77,998	--	134	26,905	2,989	--	144	4,455	112,625
14e-31	Black Canyon Cr.	81,659	--	--	19,835	37,863	1,495	315	4,870	146,037
14e-32	Soap Cr.	93,892	6,089	4,507	6,520	--	--	875	610	112,493
14e-33	Beauvais Cr.	164,624	30,745	1,122	13,360	--	--	351	966	211,168
14e-34	Rottén Grass Cr.	128,322	6,520	17,088	13,040	--	--	1,189	470	166,629
14e-35	Two Leggins-Woody Cr.	140,386	16,163	15	6,832	--	--	302	109	163,807
14e-36	Warren Bench	2,226	4,485	--	10	--	--	27	60	6,808
14e-37	West Side Bighorn River	111,631	22,592	3,606	12,820	--	--	1,680	85	152,414
14e-37a	Two Leggins Irr. Unit	685	1,070	27,085	1,100	--	--	2,481	360	32,781
14e-38	East Side Bighorn River	108,688	3,142	321	4,620	--	--	252	285	117,308
14e-39	Upper Tullock Cr.	123,431	--	--	14,240	--	--	186	10	137,867
14e-40	Lower Tullock Cr.	148,817	3,966	795	5,876	--	--	658	140	160,252
	Subbasin Total	1,308,177	95,943	56,454	202,509	76,024	1,694	9,236	12,972	1,763,009
	Little Bighorn Subbasin									
14e7-1	Little Bighorn	60,310	5,960	6,773	11,520	--	2,790	853	140	88,346
14e7-2	Pass Cr.	10,363	1,753	696	1,250	--	--	266	20	14,348
14e7-3	Lodge Grass Cr.	78,066	8,258	2,234	17,280	--	598	1,602	900	108,938
14e7-4	Owl Cr.	130,106	8,004	1,042	18,430	--	--	918	59	158,559
14e7-5	Little Bighorn E. Side	129,197	4,326	250	6,080	--	--	1,328	140	141,321
14e7-6	Little Bighorn W. Side	91,681	21,377	6,139	4,610	--	--	2,262	140	126,209
	Subbasin Total	499,723	49,678	17,134	59,170	--	3,388	7,229	1,399	637,721
	Summary									
Stillwater Subbasin		373,344	19,815	29,252	212,078	--	33,700	4,534	3,958	676,681
Yellowstone Minor Drainages		668,349	103,628	39,951	110,260	--	--	10,996	2,025	935,209
Clarks Fork Subbasin		459,513	75,492	88,628	105,005	171,977	54,840	11,342	9,531	976,328
Bighorn Subbasin		1,308,177	95,943	56,454	202,509	76,024	1,694	9,236	12,972	1,763,009
Little Bighorn Subbasin		499,723	49,678	17,134	59,170	--	3,388	7,229	1,399	637,721
TOTALS		3,309,106	344,556	231,419	689,022	248,001	93,622	43,337	29,885	4,988,948

Source: River Basin Planning Staff

Note: The terms "grass" and "brush" refer to dominant species in the vegetative cover as defined by BLM. "Trees" refers to lands with over 10 percent canopy of either upland forests or wooded bottom lands as defined by FS. Alpine and barren lands are basically rock outcropping or unvegetated badlands. Urban and builtup includes towns, airports, roads, highways, railroads, and industrial sites.

TABLE II-5--FORESTED LAND AREA BY STAND SIZE CLASS AND OWNERSHIP, 1971

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Stand Class	Total	National Forest	Public Domain	Indian Trust Land	State & Private
	- - - - - - - -	- - - - - - - -	a c r e s	- - - - - - - -	- - - - - - - -
Sawtimber	105,075	53,266	---	21,051	30,758
Poles	65,281	42,452	---	2,615	20,214
Seedlings & Saplings	99,311	82,611	---	292	16,408
SUBTOTAL - Commercial	270,967	178,329	1,300	23,958	67,380
Non-commercial	285,827	67,300	7,900	53,650	156,977
Reserved	59,390	59,390	NA	NA	NA
TOTAL	616,184	305,019	9,200	77,608	224,357

Source: River Basin Planning Staff and land administration agencies.

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

C-1 Cryoborolls-Cryoborolfs-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.

C-3 Cryoborolls-Rock outcrop association: steep, shallow to deep, well-drained soils and rock outcrops on dissected mountain fronts and rounded knolls and ridges of mountains.

C-4 Cryorthents-Cryoborolls association: nearly level to steep, shallow to deep, well-drained soils on terraces and fans in valleys and on dissected uplands of the mountains.

SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.

F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.

F-5 Ustorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills.

F-6 Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills

F-7 Ustifluvents-Argiborolls-Haploborolls association: nearly level to rolling, deep, well and moderately well-drained soils on flood plains, terraces and fans on mountain foothills.

F-8 Ustorthents-Argiborolls association: rolling and steep, shallow to deep, well-drained soils on mountain foothills.

SOILS OF THE DESERTIC BASINS AND UPLANDS

M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.

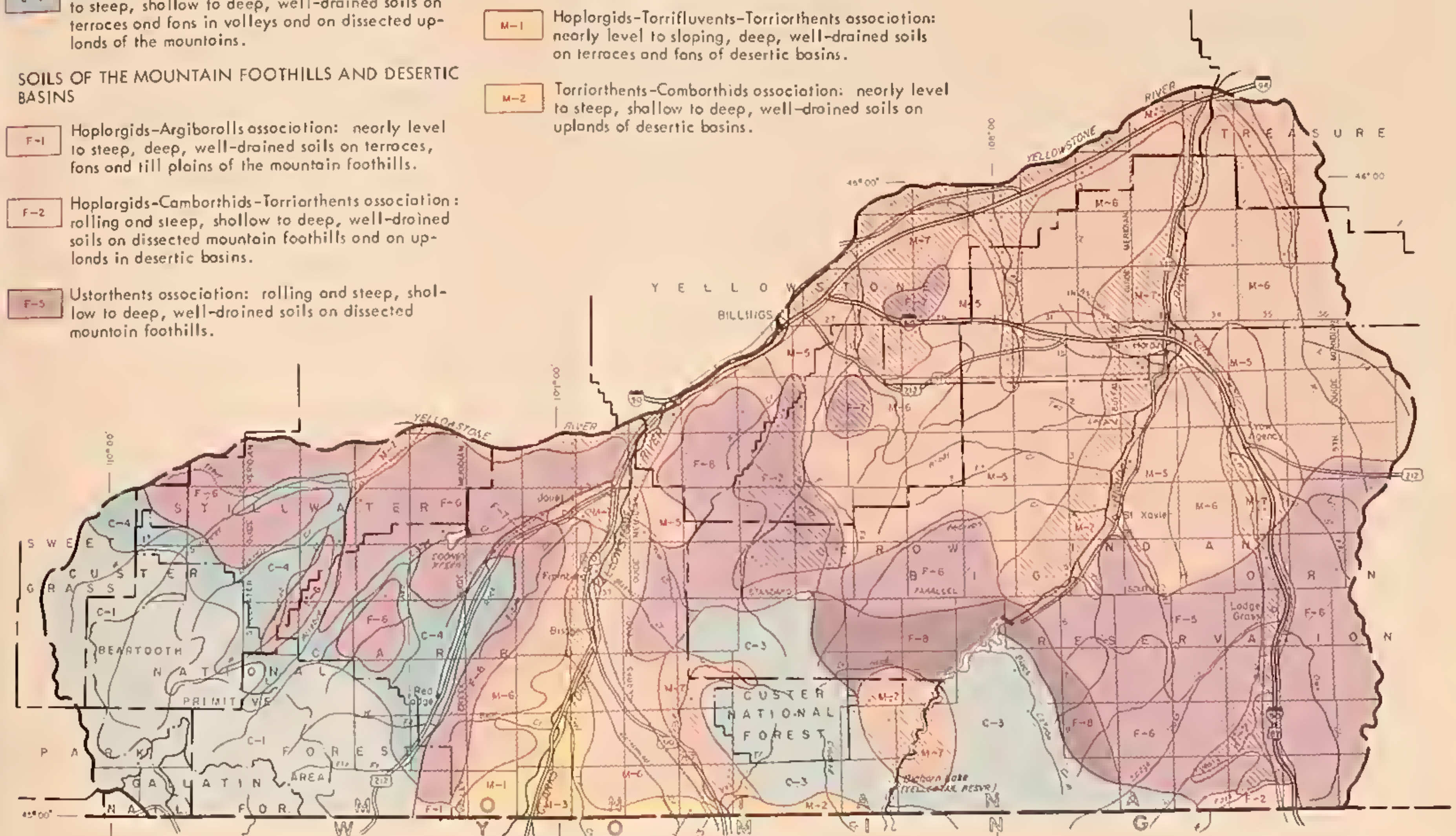
M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.

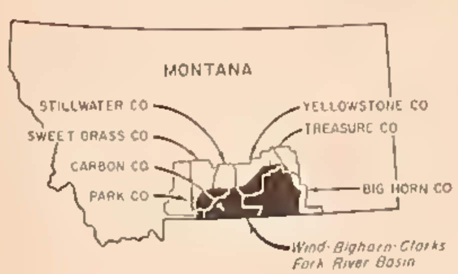
M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.

M-5 Torriorthents association: nearly level to steep, shallow to deep, well-drained soils on uplands.

M-6 Haplargids-Torriorthents-Argiustolls association: nearly level to very steep, shallow to deep, well-drained soils on dissected uplands.

M-7 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on flood plains, terraces and fans in uplands.





LOCATION MAP

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

MAP II-3

GENERALIZED SOIL MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

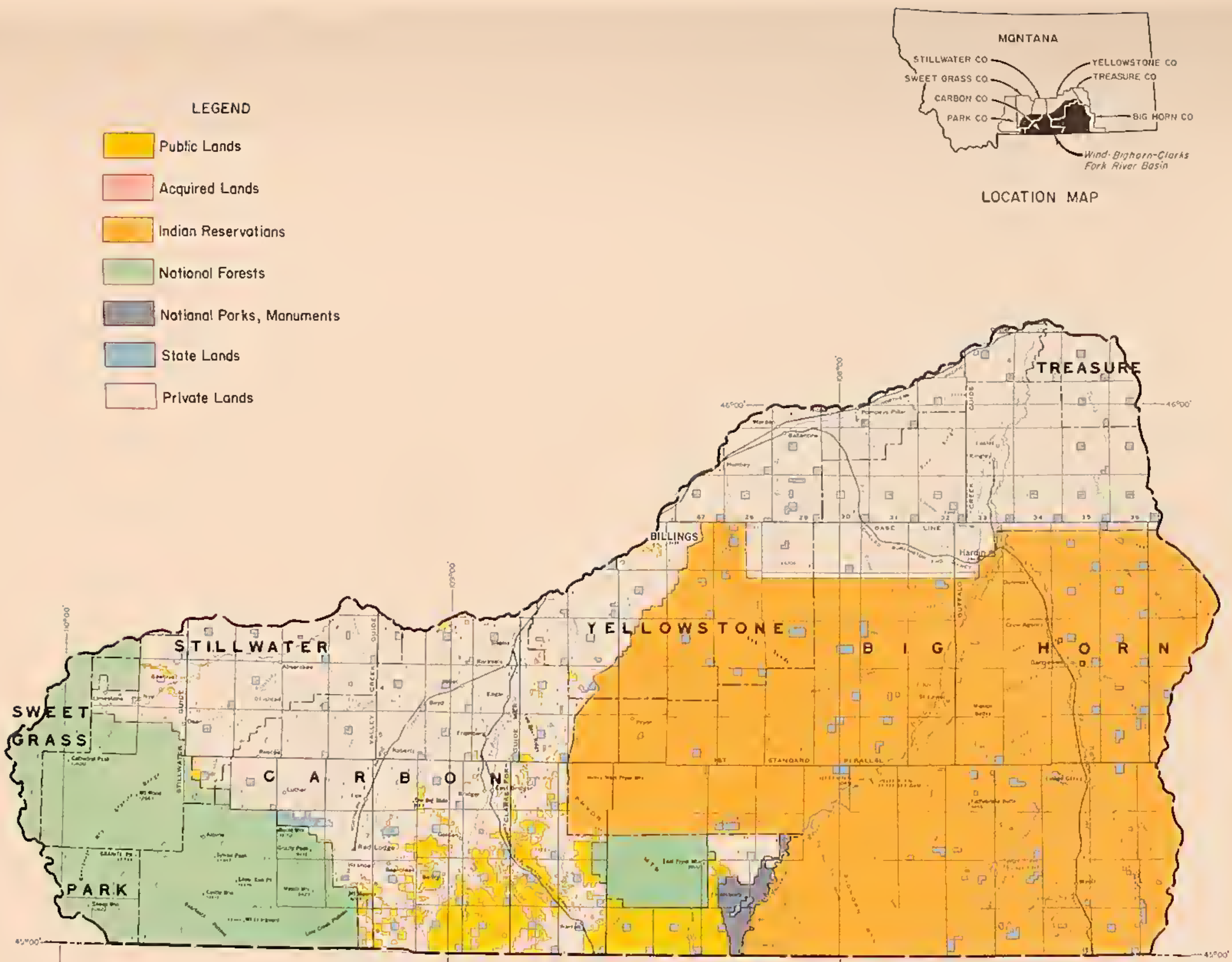
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914B-N



MAP II-4

LAND OWNERSHIP & ADMINISTATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914C-N

In addition to the forage production of the grass and brush land, there is considerable value from watershed protection. The better the vegetative cover, the less the erosion and sediment production and the better the quality of runoff water for fishery and other purposes. At present, about one million acres of range are adequately treated while about two and one-half million acres need additional and continuing land treatment.

In descending order, additional vegetative aspects and land uses are: trees, 14 percent; dry cropland, 7 percent; brush, 5 percent; irrigated crops, 4 percent; alpine and barren, 2 percent; urban and builtup, 1 percent; and water, 1 percent. There are about 28,000 acres of highway and county road rights-of-way included in the urban and builtup category. See table II-4 (Vegetative Aspect by Watersheds), map II-5 (Vegetative Aspect), and map II-6 (Irrigable and Irrigated Lands).

Forested Land

Forested lands in the Montana portion of the Wind-Bighorn Basin total about 616,184 acres.1/ The breakdown of land ownership and administration of forested land is shown in table II-5 indicating the majority is federally administered. Of the total forested land, 59,390 acres have been set aside in the Beartooth Primitive Area. In addition to the removal of these acres from timber production, another 285,827 acres have been classified as noncommercial forest due to unproductive sites, lack of access, steepness of slopes, etc. This leaves only 270,967 acres from which timber harvest may presently be taken.

Less than half these producing acres (table II-5) are stocked with sawtimber size trees (11 inches and over). The remainder shows 24 percent in the 5- to 11-inch size class and 37 percent in the less

---

1/ Forested lands are defined in this report as land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, lands from which trees have been removed to less than 10 percent stocking which have not been developed for other uses are still defined as forest lands. These numbers will not necessarily agree with the numbers in table II-4 which were derived under different criteria. Commercial forest land is that which is capable of producing an economically usable harvest of wood (usually at least 20 cubic feet per acre per year) and is not withdrawn or reserved from cutting.

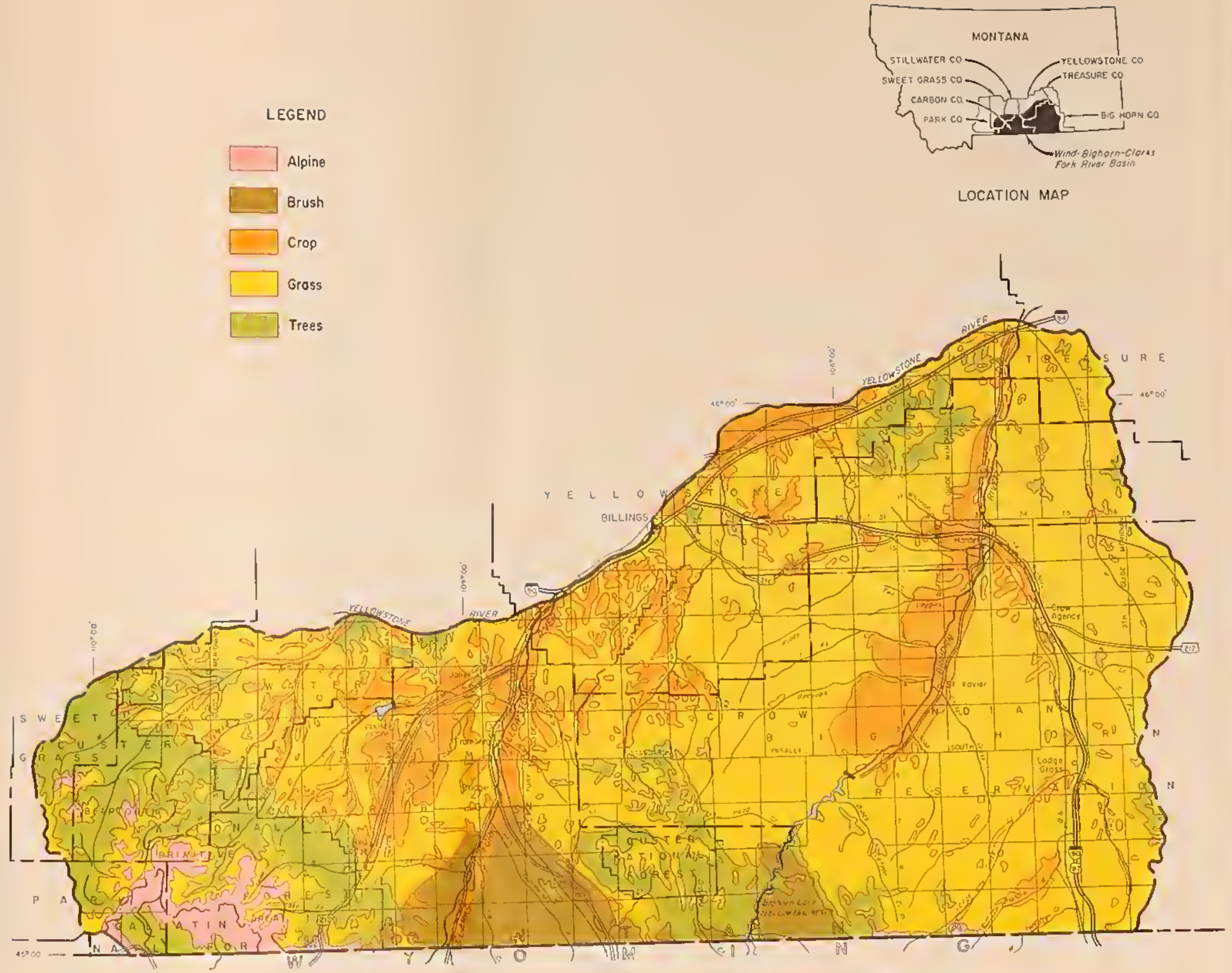
than 5-inch size class. However, these figures do not necessarily mean that the smaller trees will grow to sawtimber size with time. Much of the smaller timber is composed of stagnated stands which are relatively old, that will not significantly increase growth even if thinned. Therefore, the availability of timber for future harvest is not consistent within the figures shown on an acre-for-acre basis.

The primary species of trees in the Basin are shown in table II-6. The use of cut timber does not differentiate among species to a significant degree.

TABLE II-6--FORESTED LAND BY TYPE AND OWNERSHIP
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Forest Type	National Forest	Public Domain	Indian Trust Land	State & Private
	- - - - - - - - - - - -	- - - - - Acres	- - - - -	- - - - - - - -
Lodgepole Pine	48,149	NA	NA	NA
Spruce	19,616	do	do	do
Alpine Fir	21,399	do	do	do
Douglas-Fir	64,198	do	do	do
Ponderosa Pine	2,496	do	do	do
Whitebark-limber Pine	21,400	do	do	do
Other	1,071	do	do	do
Noncommercial	67,300	7,900	53,650	156,977
Reserved	59,390	NA	NA	NA
TOTAL	305,019	9,200	77,608	224,357

Source: U. S. Forest Service



MAP II-5

VEGETATIVE ASPECT

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

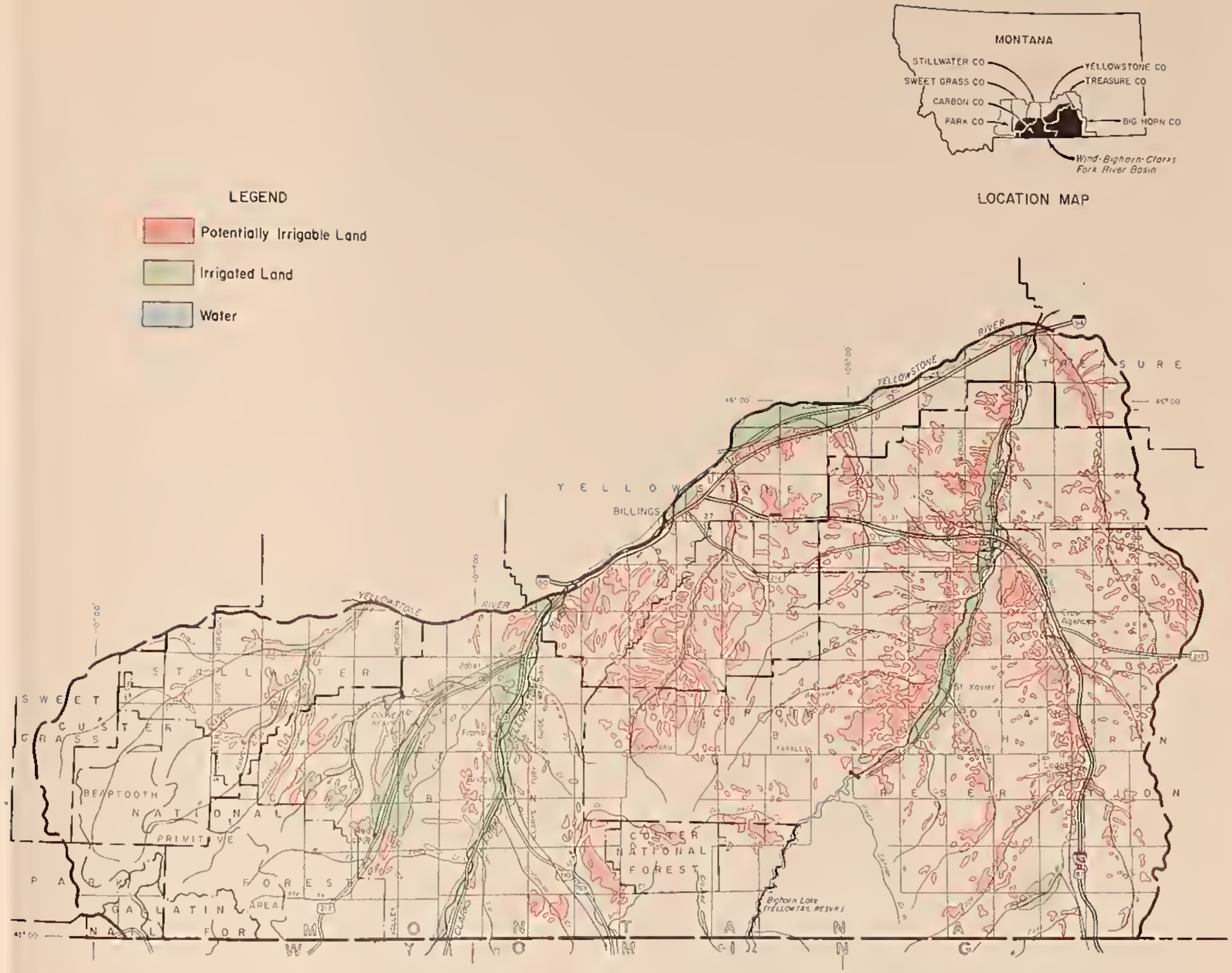
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914D-N



MAP II-6

IRRIGABLE AND IRRIGATED LAND

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1 : 1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914E-N

WATER RESOURCES

Surface Water Supplies

Water resources available for use in the Montana part of the Basin depend largely on melting snows in the high country and on Yellowstone River Compact water entering from Wyoming in the Bighorn, Little Bighorn, and Clarks Fork Rivers. Snowmelt runoff is augmented to a lesser degree by summer rainstorms. Surface water quality is suitable for most purposes. Water yield from the high country ranges up to 2,700 acre-feet per square mile per year as contrasted to almost zero yield from the desert and semidesert lower elevations. See map II-7. Seasonal distribution of runoff is typical of western mountainous snowpack drainages. More water is available during the spring and early summer months than can be used on the irrigable lands through direct diversion. Flows drop rapidly, as the snowmelt is depleted, leaving a water deficit during late summer and early fall. See typical hydrographs shown in figure II-1. See tables II-7 and II-8.

Irrigated lands in the Basin were inventoried by four types of systems and availability of water. Type I lands are defined as those with a relatively adequate supply and improved conveyance systems. Type II lands are those with less efficient systems and water management. Water supply ranges from severe shortages to nearly adequate. Type III's are the "mountain meadow" lands which are short of water after the initial runoff. Normally, they receive only one irrigation. Because of the water shortages, other inputs are minimal and productivity is low. Type IV lands are those with various types of water-spreading systems. They may go through an entire growing season without irrigation. Some of the lands have regular flood irrigation systems, but are used only when water is available from runoff. See table II-9.

Water use and management are affected by the seasonality of supply, the original pattern of appropriation and development, the limitation of cropping alternatives, and the diversity of soil types irrigated and through which canals are constructed. Water conveyance efficiencies range from 80 percent on heavy soils to 20 percent on lighter soils. On-farm application efficiencies range from 60 percent on the better-developed, nearly level bottom lands to 15 percent for steeper mountain meadow irrigation. As a result of the combination of these efficiencies, overall project efficiencies range from a high of 48 percent to a low of 7 or 8 percent. In other words, for each acre-foot of irrigation water used by the crop, it requires diversion of from 2.86 acre-feet of water at 35 percent efficiency to 12.5 acre-feet of water at 8 percent efficiency.

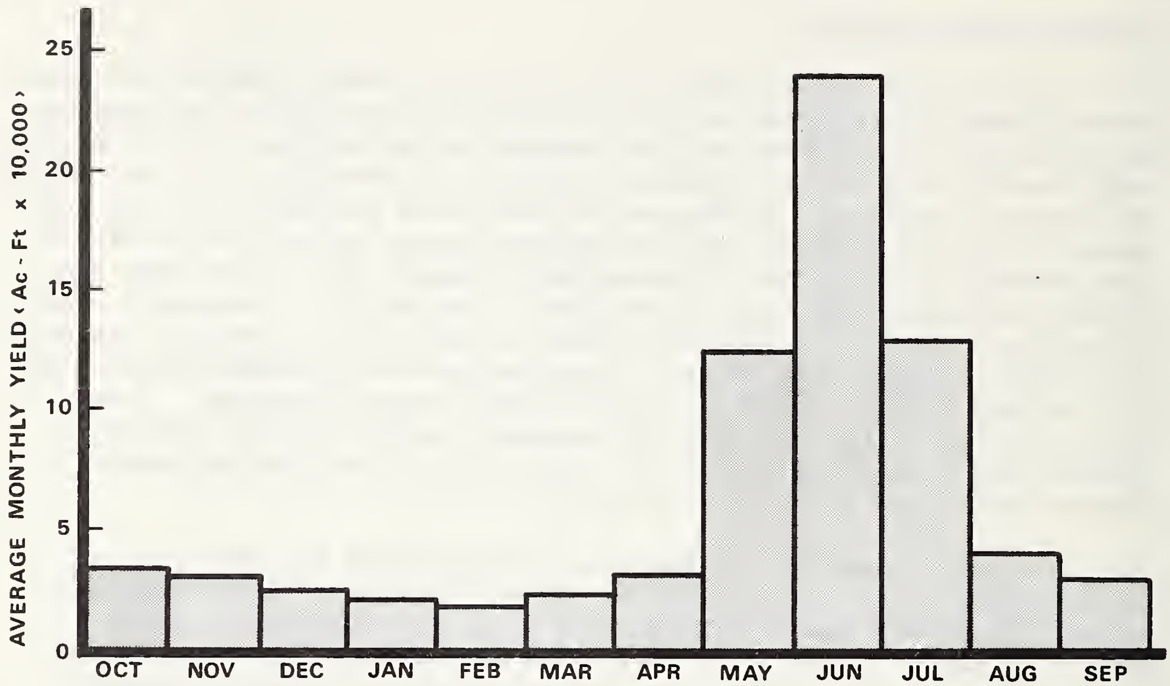


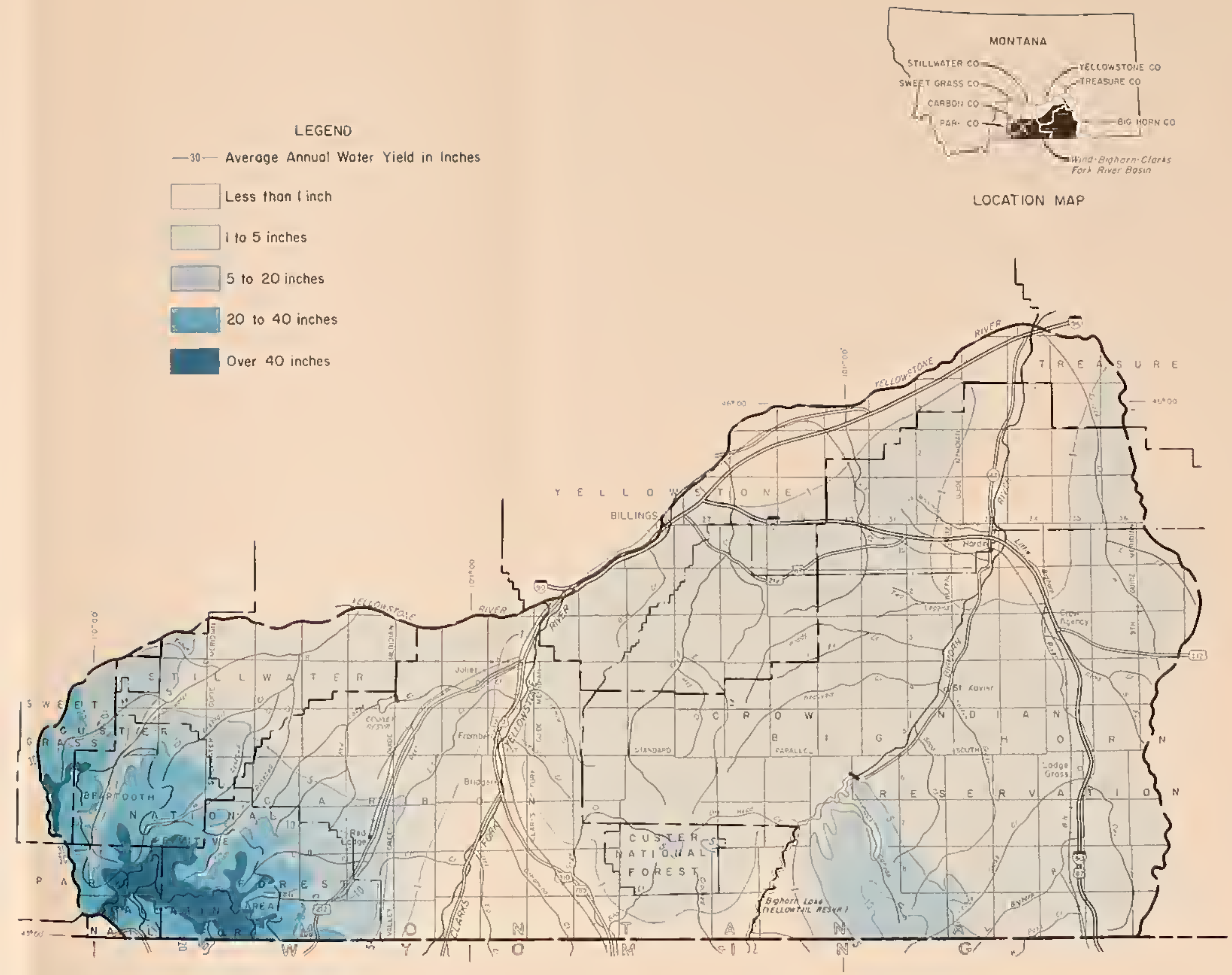
FIGURE II-1 -- TYPICAL WATER YIELD HYDROGRAPH

TABLE II-7--WATER SURFACE AREA BY SUBBASIN
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Surface Acres of Lakes, Ponds and Reservoirs	Miles of Live Streams and Rivers
	- - acres - - -	- - miles - -
Stillwater Subbasin	3,958	338
Yellowstone Minor Drainages	2,025	129
Clarks Fork Subbasin	9,531	409
Bighorn Subbasin	12,972	402
Little Bighorn Subbasin	1,399	173
Total	29,885	1,451 1/

Source: River Basin Planning Staff

1/ Does not include 119 miles of Yellowstone River.



MAP II-7

AVERAGE ANNUAL WATER YIELD

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914 F-N

TABLE II-8--ESTIMATED SURFACE WATER RESOURCES, 1970
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Numbers	Hydrologic Subareas	Phreatophyte Area	Presently Irrigated Land	50 PERCENT CHANCE: Total Native Water Yield [1/]	Flows From Upstream Sources	Phreatophyte Depletion	Reservoir Effect and Evaporation	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point	80 PERCENT CHANCE: Total Native Water Yield [1/]	Flows From Upstream Sources	Phreatophyte Depletion	Reservoir Effect and Evaporation	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point
		--Acres--	--Acres--	Acre-Feet							Acre-Feet						
	Stillwater Subbasin																
14b-1	Upper Stillwater River	1,568	768	397,590	0	4,700	0	392,890	1,230	391,660	328,790	0	4,700	0	324,090	1,230	322,860
14b-2	Fishtail to Butcher Cr.	1,510	18,843	367,370	0	6,040	0	361,330	30,150	331,180	302,430	0	6,040	0	296,390	30,150	266,240
	Diversion to Red Lodge Cr.								16,700							24,510	
14b-3	Lower Stillwater River	760	5,490	61,370	0	3,420	0	57,950	8,780	49,170	50,390	0	3,420	0	46,970	8,780	38,190
14b-4	Shane-Beaver Cr.	920	4,151	24,070	0	4,600	0	19,470	6,640	12,830	19,770	0	4,600	0	15,170	6,640	8,530
	Subbasin Total	4,758	29,252	850,400	0	18,760	0	831,640	63,500	768,140	701,380	0	18,760	0	682,620	71,310	611,310
	Yellowstone Minor Drainages																
14-22	Cow-Bellion Creek	978	1,610	4,660	4,000,000[4/]	6,850	0	3,997,810	2,580	3,995,230	3,350	3,400,000[4/]	6,850	0	3,396,500	2,580	3,393,920
14-27	Blue-Duck Creek	410	3,124	8,720	813,930[2/]	2,870	0	819,780	5,000	814,780	6,270	676,230[2/]	2,870	0	679,630	5,000	674,630
14-31	Arrow Creek	400	27,990	5,360	0	3,000	0	2,360	44,780[4/]	0	3,850	0	3,000	0	850	44,780[4/]	0
14-32	Fly Creek	230	1,250	13,170	0	1,730	0	11,440	2,000	9,440	9,470	0	1,730	0	7,740	2,000	5,740
14-36	Lost Boy Creek	340	1,058	6,690	0	2,550	0	4,140	1,700	2,440	4,780	0	2,550	0	2,230	1,700	530
14-37	Custer Drainage	170	2,200	1,570	0	1,280	0	290	3,520[4/]	0	1,130	0	1,280[4/]	0	0	3,520[4/]	0
14d-1	Upper Pryor Creek	580	1,371	46,120	0	2,900	0	43,220	2,190	41,030	31,490	0	2,900	0	28,590	2,190	26,400
14d-2	Lower Pryor Creek	680	1,348	12,340	0	4,080	0	8,260	2,160	6,100	9,220	0	4,080	0	5,140	2,160	2,980
	Subbasin Total	3,788	39,951	98,630	4,813,930	25,260	0	4,887,300	63,930	4,823,370	69,560	4,076,230	25,260	0	4,120,530	63,930	4,056,600
	Clarks Fork Subbasin																
14c-3	Clarks Fork-Zimmer Cr.	2,216	0	223,460[9/]		6,660[9/]	0	216,800[9/]	0	216,800[9/]	183,960[9/]		6,660[9/]	0	177,300[9/]	0	177,300[9/]
14c-5	Line Creek	26	0	14,000[9/]	0	100[9/]	0	13,900[9/]	0	13,900[9/]	12,000[9/]	0	100[9/]	0	11,900[9/]	0	11,900[9/]
	Clarks Fork River				660,000[3/]			660,000[3/]		660,000[3/]		560,000[3/]			560,000[3/]		560,000[3/]
14c-4	Pat O'Hara Cr.	2	112	20	0	20	0	0	180[2/]	0	20	0	20	0	0	180[2/]	0
14c-4a	Big Sand Coulee	29	968	270	3,200[3/]	290	0	3,180	1,550	1,630	230	2,200[3/]	290	0	2,140	1,550	590
14c-6	N.F. Cherry-Silvertip Cr.	510	10,633	6,600	1,800[3/]	2,300	0	6,100	17,010[2/]	0	5,530	1,300[3/]	2,300	0	4,530	17,010[2/]	0
14c-7	Clarks Fork-Ruby Cr.	380	11,385	44,350	0	2,280	0	42,070	18,220	23,850	35,320	0	2,280	0	33,040	18,220	14,820
14c-8	Upper Rock Cr.	3,628	40	147,350	31,500[3/]	18,140	0	160,710	60	160,650	141,460	26,000	18,140	0	149,320	60	149,260
14c-9	Red Lodge--Rock Cr.	6,508	39,308	74,410	16,700[5/]	32,540	3,200	55,370	62,890[6/]	0	59,280	24,510[5/]	32,540	2,400	48,850	62,890[6/]	0
14c-10	Elbow-Lower Rock Cr.	1,294	19,100	11,800	0	7,760	0	4,040	28,830[6/]	0	9,400	0	7,760	0	1,640	28,830[6/]	0
14c-11	Lower Clarks Fork E. Side	820	7,082	28,270	0	5,740	0	22,530	11,330	11,200	22,520	0	5,740	0	16,780	11,330	5,450
	Subbasin Total	15,413	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930	273,760	614,010	69,070	2,400	816,300	140,070	676,230

See footnotes on following page.

TABLE II-B--ESTIMATED SURFACE WATER RESOURCES, 1970 (Continued)

Watershed Numbers	Hydrologic Subareas	Phreato-phyte Area	Presently Irrigated Land	50 PERCENT CHANCE: Total Native Water Yield 1/	Flows From Upstream Sources 3/	Phreato-phyte Depletion	Reservoir Effect and Evapora-tion	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point	80 PERCENT CHANCE: Total Native Water Yield 1/	Flows From Upstream Sources 3/	Phreato-phyte Depletion	Reservoir Effect and Evapora-tion	Available Water Supply	Irrigation Depletion	Remaining Water Supply At Outlet Point
		-------Acres-------		- - - - - - - Acre-Feet - - - - - - -							- - - - - - - Acre-Feet - - - - - - -						
	Bighorn Subbasin																
14e6-8	Sage Creek	440	1,449	22,340[9]	0	3,080[9]	0	19,260[9]	2,320[9]	16,940[9]	16,320[9]	0	3,080[9]	0	13,240[9]	2,320[9]	10,920[9]
14e6-8a	Dry Creek	20	0	690[9]	0	140[9]	0	550[9]	0	550[9]	500[9]	0	140[9]	0	360[9]	0	360[9]
14e-27	Crooked Creek	200	332	14,200[9]	0	1,200[9]	0	13,000[9]	530[9]	12,470[9]	10,380[9]	0	1,200[9]	0	9,180[9]	530[9]	8,650[9]
	Bighorn River	0	0	0	2,362,000	0	0	2,362,000	0	2,362,000	0	1,800,000	0	0	1,800,000	0	1,800,000
14e-28	Porcupine Creek	20	0	3,090	34,000	120	0	36,970	0	36,970	1,500	27,000	120	0	28,380	0	28,380
14e-30	Dryhead Creek to Wyoming	580	134	16,030	0	4,060	0	11,970	220	11,750	7,170	0	4,060	0	3,110	220	2,890
14e-31	Black Canyon Creek	100	0	41,560	0	700	0	40,860	0	40,860	17,410	0	700	0	16,710	0	16,710
	Yellowtail Reservoir	0	0	0	0	0	26,000	0	0	0	0	0	0	20,000	0	0	0
14e-32	Soap Creek	700	4,507	19,790	0	5,250	0	14,540	7,210	7,330	8,800	0	5,250	0	3,550	7,210[7]	0
14e-33	Beauvais Creek	1,220	1,122	23,760	0	9,150	0	14,610	1,800	12,810	9,550	0	9,150	0	400	1,800[7]	0
14e-34	Rotten Grass Creek	1,140	17,088	26,830	0	4,630	0	22,200	27,340[7]	0	10,910	0	4,630	0	6,280	27,340[7]	0
14e-35	Two Leggins-Woody Creek	920	15	12,740	0	4,560	0	8,180	20	8,160	5,680	0	4,560	0	1,120	20	1,100
14e-36	Warren Bench	40	0	230	0	190	0	40	0	40	190	0	190	0	0	0	0
	Little Bighorn River	0	0	0	174,150	0	0	174,150	0	174,150	0	124,370	0	0	124,370	0	124,370
14e-37	West Side Bighorn River	830	3,606	5,270	0	6,230[7]	0	0	5,770[7]	0	2,260[7]	0	6,230[7]	0	0	5,770[7]	0
14e-37a	Two Leggins Irrigation Unit	1,560	27,085	1,130	0	11,700[7]	0	0	43,340[7]	0	500	0	11,700[7]	0	0	43,340[7]	0
14e-38	East Side Bighorn River	1,780	321	4,050	0	13,350[7]	0	0	510[7]	0	1,810	0	13,350[7]	0	0	510[7]	0
14e-39	Upper Tullock Creek	500	0	4,760	0	3,000	0	1,760	0	1,760	3,000	0	3,000	0	0	0	0
14e-40	Lower Tullock Creek	500	795	5,680	0	3,750	0	1,930	1,170	760	4,920	0	3,750	0	1,170	1,170	0
	Subbasin Total	10,550	56,454	164,920	2,570,150	66,690	26,000	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000	1,938,380	87,380	1,851,000
	Little Bighorn Subbasin																
14e7-1	Little Bighorn River	1,560	6,773	26,660	102,000	9,080	0	119,580	10,840	108,740	24,780	82,000	9,080	0	97,700	10,840	86,860
14e7-2	Pass Creek	350	696	3,720	23,500	1,570	0	25,650	1,110	24,540	3,240	18,900	1,570	0	20,570	1,110	19,460
14e7-3	Lodge Grass Creek	2,550	2,234	33,960	12,800	15,400	1,200	30,160	3,750	26,410	29,050	10,300	15,400	1,000	22,950	3,750	19,200
14e7-4	Owl Creek	2,690	1,042	21,170	0	7,930	0	13,240	1,670	11,570	18,470	0	7,930	0	10,540	1,670	8,870
14e7-5	Little Bighorn East Side	900	250	13,040	0	6,300	0	6,740	400	6,340	5,960	0	6,300[8]	0	0	400[8]	0
14e7-6	Little Bighorn West Side	640	6,139	10,850	0	4,480	0	6,370	9,820[8]	0	5,020	0	4,480	0	540	9,820[8]	0
	Subbasin Total	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
SUMMARY																	
	Stillwater Subbasin	4,758	29,252	850,400	0	18,760	0	831,640	63,500	768,140	701,380	0	18,760	0	682,620	71,310	611,310
	Yellowstone Minor Drainages	3,788	39,951	98,630	4,813,930	25,260	0	4,887,300	63,930	4,823,370	69,560	4,076,230	25,260	0	4,120,530	63,930	4,056,600
	Clarks Fork Subbasin	15,413	88,628	313,070	713,200	69,070	3,200	954,000	140,070	813,930	273,760	614,010	69,070	3,400	816,300	140,070	676,230
	Bighorn Subbasin	10,550	56,454	164,920	2,570,150	66,690	26,000	2,642,380	87,380	2,555,000	73,700	1,951,370	66,690	20,000	1,938,380	87,380	1,851,000
	Little Bighorn Subbasin	8,690	17,134	109,400	138,300	44,760	1,200	201,740	27,590	174,150	86,520	111,200	44,760	1,000	151,960	27,590	124,370
	TOTAL	43,199	231,419	1,536,420	XXXXXXXXX	224,540	30,400	XXXXXXXXX	382,470	XXXXXXXXX	1,204,920	XXXXXXXX	224,540	23,400	XXXXXXXXX	390,280	XXXXXXXXX

Source: River Basin Planning Staff

1/ Except that inflow required to supply evaporation from flowing streams, ponds, and small lakes is not estimated.
2/ Supplied from flow of Clarks Fork River.
3/ Streamflow entering watershed from Wyoming.
4/ Supplied from flow of Yellowstone River.
5/ Diversion from East Rosebud River.
6/ Supplied from flow of Rock Creek and Cooney Reservoir storage.
7/ Supplied from flow of Bighorn River and Yellowtail Reservoir storage.
8/ Supplied from flow of Little Bighorn River.
9/ Flow crossing state line into Wyoming. Figures are not additive into subbasin totals.

TABLE II-9--IRRIGATED LANDS BY TYPE OF IRRIGATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Type of Irrigation I	II	III	IV	Total
		- - - - - - - - acres	- - -	- - -	- - -	- - -
	Stillwater Subbasin					
14b-1	Upper Stillwater River	--	--	768	--	768
14b-2	Fishtail to Butcher Cr.	1,504	12,811	4,528	--	18,843
14b-3	Lower Stillwater River	--	3,843	1,647	--	5,490
14b-4	Shane-Beaver Cr.	--	2,906	1,245	--	4,151
	Subbasin Total	1,504	19,560	8,188	--	29,252
	Yellowstone Minor Drainages					
14-22	Cow-Bellion Cr.	519	1,091	--	--	1,610
14-27	Blue-Duck Cr.	1,093	2,031	--	--	3,124
14-31	Arrow Cr.	19,593	8,397	--	--	27,990
14-32	Fly Cr.	500	500	125	125	1,250
14-36	Lost Boy Cr.	423	529	--	106	1,058
14-37	Custer Drainage	1,430	770	--	--	2,200
14d-1	Upper Pryor Cr.	10	1,361	--	--	1,371
14d-2	Lower Pryor Cr.	809	539	--	--	1,348
	Subbasin Total	24,377	15,218	125	231	39,951
	Clarks Fork Subbasin					
14c-3	Clarks Fork-Zimmer Cr.	--	--	--	--	--
14c-4	Pat O'Hara Cr.	56	56	--	--	112
14c-4a	Big Sand Coulee	726	242	--	--	968
14c-5	Line Cr.	--	--	--	--	--
14c-6	N.F. Cherry-Silvertip Cr.	10,633	--	--	--	10,633
14c-7	Clarks Fork-Ruby Cr.	9,108	2,277	--	--	11,385
14c-8	Upper Rock Cr.	--	--	40	--	40
14c-9	Red Lodge-Rock Cr.	7,862	31,446	--	--	39,308
14c-10	Elbow-Lower Rock Cr.	15,280	3,820	--	--	19,100
14c-11	Lower Clarks Fork E. Side	6,309	773	--	--	7,082
	Subbasin Total	49,974	38,614	40	--	88,628

TABLE II-9--IRRIGATED LANDS BY TYPE OF IRRIGATION (Cont'd)

(Montana)

Watershed Number	Watershed Name	Type of Irrigation I	II	III	IV	Total
		- - - - - -	- - - - - -	acres	- - - - - -	- - - - - -
	Bighorn Subbasin					
14e6-8	Sage Cr.	273	1,176	--	--	1,449
14e6-8a	Dry Cr.	--	--	--	--	--
14e-27	Crooked Cr.	--	--	332	--	332
14e-28	Porcupine Cr.	--	--	--	--	--
14e-30	Dryhead Cr. to Wyo.	--	--	134	--	134
14e-31	Black Canyon Cr.	--	--	--	--	--
14e-32	Soap Cr.	1,803	2,479	225	--	4,507
14e-33	Beauvais Cr.	--	1,010	112	--	1,122
14e-34	Rotten Grass Cr.	11,107	5,126	855	--	17,088
14e-35	Two Leggins-Woody Cr.	--	--	--	15	15
14e-36	Warren Bench	--	--	--	--	--
14e-37	West Side Bighorn River	2,356	1,250	--	--	3,606
14e-37a	Two Leggins Irr. Unit	18,960	8,125	--	--	27,085
14e-38	East Side Bighorn River	--	321	--	--	321
14e-39	Upper Tullock Cr.	--	--	--	--	--
14e-40	Lower Tullock Cr.	406	174	--	215	795
	Subbasin Total	34,905	19,661	1,658	230	56,454
	Little Bighorn Subbasin					
14e7-1	Little Bighorn River	--	6,773	--	--	6,773
14e7-2	Pass Cr.	--	557	139	--	696
14e7-3	Lodge Grass Cr.	--	2,234	--	--	2,234
14e7-4	Owl Cr.	--	1,042	--	--	1,042
14e7-5	Little Bighorn E. Side	--	250	--	--	250
14e7-6	Little Bighorn W. Side	3,683	2,456	--	--	6,139
	Subbasin Total	3,683	13,312	139	--	17,134
	Summary					
Stillwater Subbasin		1,504	19,560	8,188	--	29,252
Yellowstone Minor Drainages		24,377	15,218	125	231	39,951
Clarks Fork Subbasin		49,974	38,614	40	--	88,628
Bighorn Subbasin		34,905	19,661	1,658	230	56,454
Little Bighorn Subbasin		3,683	13,312	139	--	17,134
TOTALS		114,443	106,365	10,150	461	231,419

Source: River Basin Planning Staff

Quality of Water

The quality of surface water and shallow ground water is suitable for irrigation in most places in the Basin. These waters are considered "hard" in that they generally contain considerably higher concentrations of calcium and magnesium ions than of sodium ions. Such waters are suitable for irrigation of most soils. "Soft" waters that have higher concentrations of sodium ions than of calcium and magnesium ions tend to deflocculate clay in the soil, dissolve humus, and cause puddling and water logging conditions. Water close to the Beartooth Mountains is low in dissolved solids and is relatively soft, but salt concentrations closer to the Yellowstone River have been increased by ground-water return flows.

The quality of ground water is generally good except where it flows through saline shales. In such areas the yield from wells is not sufficient to consider its use for irrigation and excessive salts often make it unusable for human and livestock consumption. See maps II-8 and II-9.

Water derived from bedrock aquifers is normally soft, containing a high ratio of sodium to calcium-magnesium and is considered generally unsatisfactory for irrigation. Water is satisfactory for domestic and stock use if the quantity of dissolved solids is not excessive. Very deep aquifers tend to be lower in quality for two reasons: (1) they have greater opportunity for contamination by salts from poor recharge sources such as marine shales; (2) deep water moves through the rocks more slowly, which gives it greater opportunity to dissolve minerals from the aquifers. Ground water can range widely in quality within a relatively short distance because permeabilities within an aquifer may change rapidly, particularly in the Tertiary formations.

Ground water from the Chugwater, Madison, and Amsden formations is an exception to the general "soft water" rule. This water is very hard, coming from formations which are high in calcium and magnesium carbonates. It is generally satisfactory for irrigation on well-drained soils. Spring water is utilized at the Montana Department of Fish and Game fish hatchery on Bluewater Creek. These artesian aquifers in fractured zones show the greatest potential for future development of large volumes of ground water.

Alluvial ground water in the eastern portion of the Basin in Montana is normally very hard and high in dissolved solids. Effluent recharge from adjacent shaly bedrock and irrigation return waters is usually not of potable quality. The water is generally satisfactory for irrigation when there is recharge from surface flow to the aquifer and when used on well-drained soils. Ground water in the Big Horn Valley is too high in salts for domestic and stock use and very little is used north of St. Xavier.

Ground-Water Supplies

Ground water is widely used throughout the Basin as a source of domestic, industrial, irrigation, municipal, and livestock water. A ground-water inventory was made and relevant maps were constructed. Formation symbols, geologic structures, and the outline of areas covered by publications that pertain to ground-water studies are shown. An indication of general ground-water quality is mentioned in the description. Maps II-8 and II-9 and the stratigraphic legend show potential aquifers from which water can usually be obtained from wells and springs.

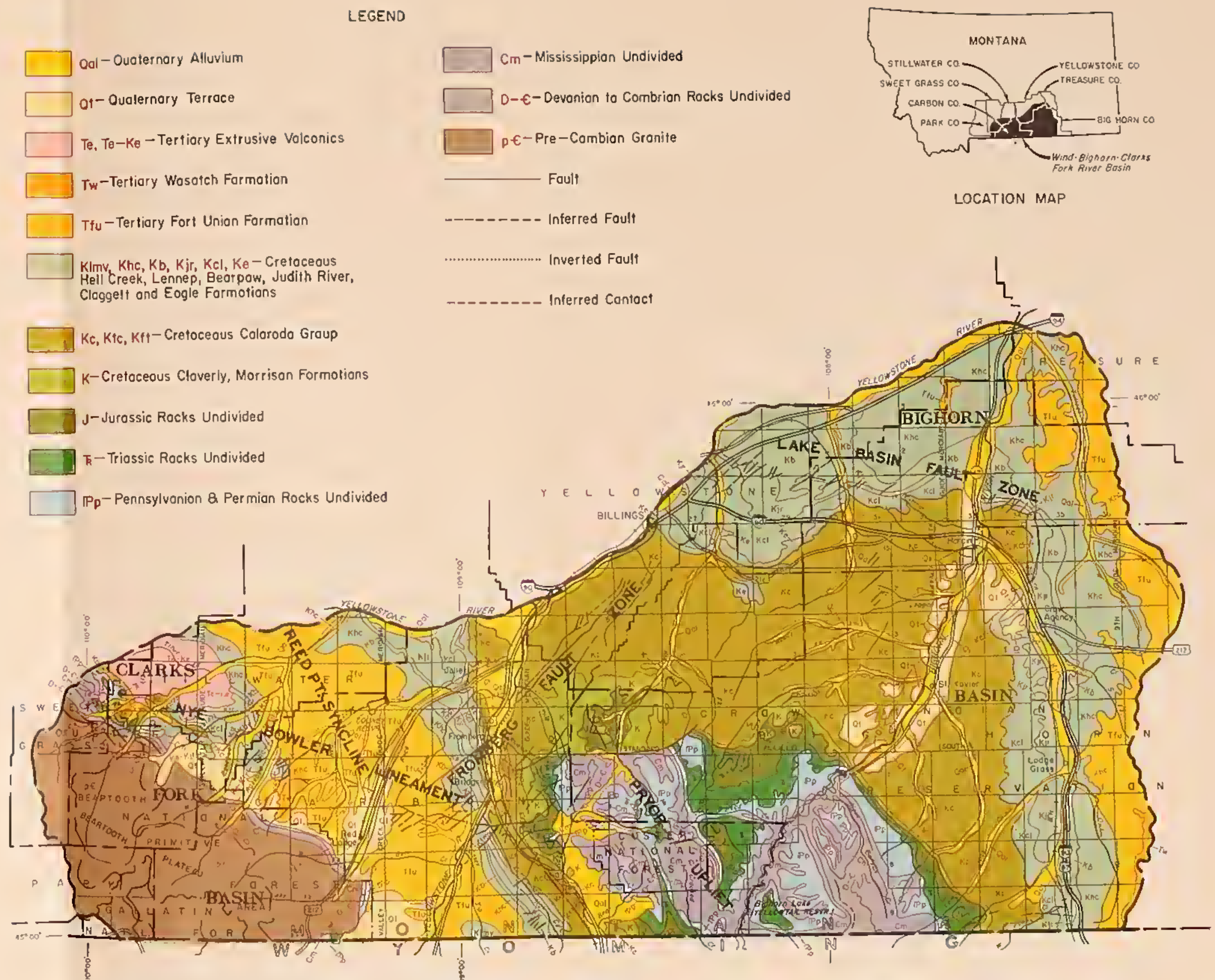
Map II-9 shows the availability of water from bedrock aquifers, depth of the regional water table, and anticipated total depth for wells. Most wells drilled to bedrock yield less than 25 gallons per minute per foot of drawdown. Many yield less than three gpm per foot of drawdown. The Chugwater-Tensleep-Madison series is capable of yielding water around 25 gpm when conditions are favorable. The Madison is cavernous at some locations, and these rocks are normally fractured because of their brittle nature. At locations of large hydrostatic head and large void ratio, substantial yields are possible. One well on Bluewater Creek flows 8.3 cubic feet per second (cfs) or 3,700 gpm.

Moderately large yields are possible from the alluvium at some locations. The greatest yields are obtained close to the mountains where a greater abundance of sand and gravel exists. Yields average about 300 gpm per well or an average of 10 gpm per foot of drawdown. Exceptional wells of 1,000-2,000 gpm have been reported. There is an opportunity for development of a greater number of irrigation and industrial wells from alluvial sources. At some locations, there may be a conflict between ground-water and surface water rights.

Areas of high elevation in the Pryor and Bighorn Mountains have a deep regional water table. Well depths and pump lifts must necessarily be great except where shallow developments are possible from perched water tables.

Metamorphic and volcanic rocks in the Beartooth uplifted areas are normally hard and have low permeability except in the zone of surficial weathering. Best chances of domestic and stock water development are in the valley areas.

Areas of shale formations are shown on the map. Wells in these formations must normally be deep to penetrate the shale and obtain water from underlying aquifers. Occasionally there is an opportunity to obtain water from alluvial material when it is recharged with good quality water. Water within shale aquifers normally has too high a



MAP II-8
GENERALIZED GEOLOGY
WIND-BIGHORN-CLARKS FORK RIVER BASIN
MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

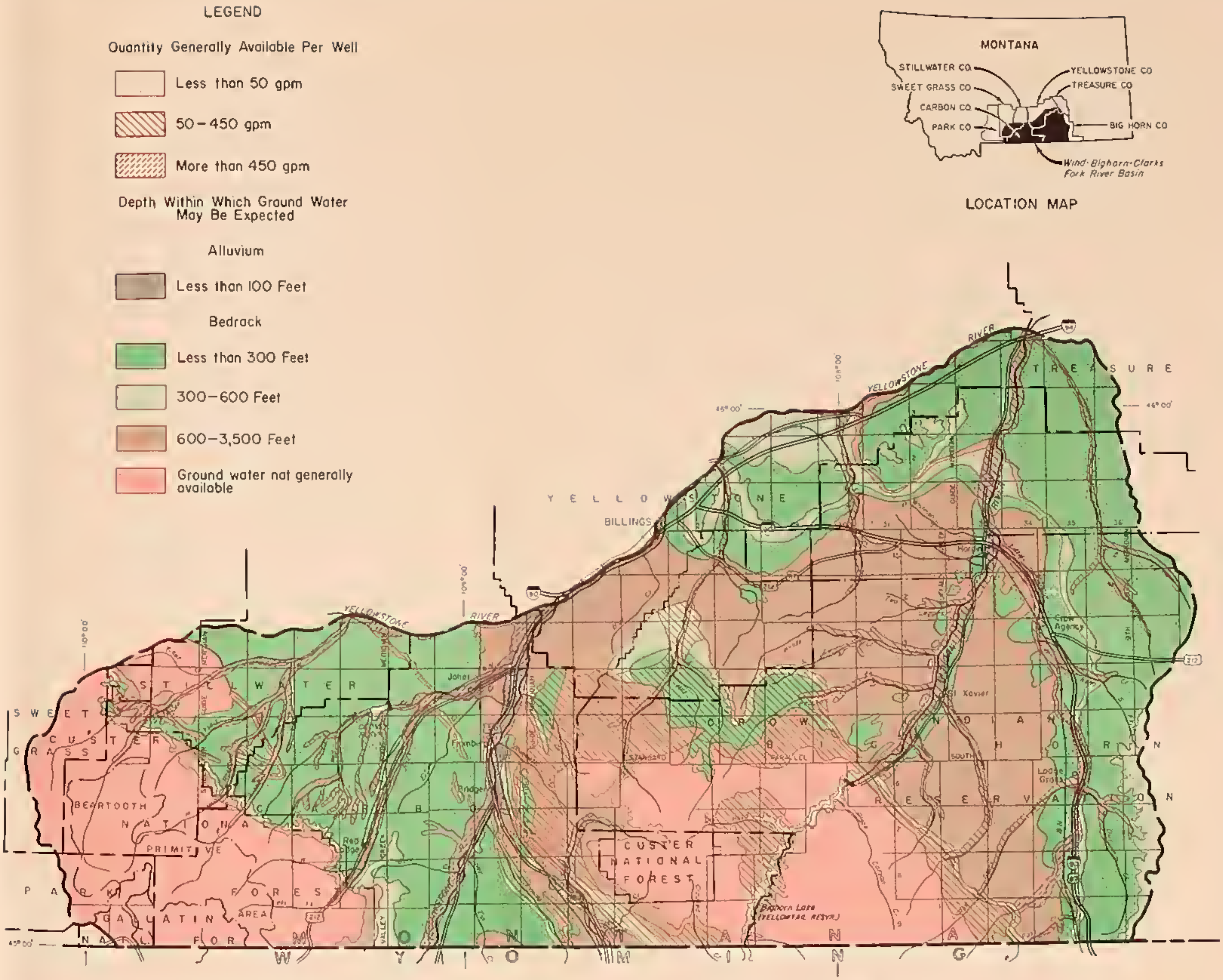
APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914G-N



MAP II-9

GENERAL AVAILABILITY OF GROUND WATER

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914 H-N

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450+ gpm	Fair to Good
			River Terrace	Water Bearing	Less than 50 gpm	Fair to Good
TERTIARY	EOCENE PALEOCENE		Wasatch-Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		*Extrusive Pyroclastics	Non-Water Bearing		
			Hell Creek Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
			Lennep Sandstone	Water Bearing	Less than 50 gpm	Fair to Good
			*Bearpaw Shale	Non-Water Bearing		
			Judith River Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			*Claggett Shale	2/ Non-Water Bearing	2/ Less than 50 gpm	Poor to Fair
			Eagle Sandstone	Water Bearing	*** Less than 50 gpm	Fair to Good
		COLORADO GROUP	Telegraph Creek Formation	Water Bearing	Less than 50 gpm	Fair to Poor
			Niobrara Formation	Non-Water Bearing		
			*Cody Shale	Non-Water Bearing		
			*Carlile Shale	Non-Water Bearing		
			*Greenhorn Formation	Non-Water Bearing		
			Frontier Formation	Non-Water Bearing		
	LOWER		Frontier, Torchlight Member	Water Bearing	*** Less than 50 gpm	Poor
			Belle Fourche Shale	Non-Water Bearing		
			*Mowry Shale	Non-Water Bearing		
			Muddy Sandstone	Water Bearing	Less than 50 gpm	Poor
			*Thermopolis Shale	Non-Water Bearing		
			Cloverly Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Morrison Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			Swift Formation	Water Bearing	Less than 50 gpm	Poor to Fair
			Rierdon Formation	Non-Water Bearing		
			Sundance Formation	Water Bearing	Less than 50 gpm	Poor
			*Gypsum Spring-Piper Formation	Non-Water Bearing		
TRIASSIC			*Chugwater Formation	Non-Water Bearing		
			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone	Water Bearing	*** 50 - 450 gpm	Fair to Good
			Amsden Formation	Water Bearing	*** 50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	*** 50 - 450 gpm	Good
DEVONIAN			Jefferson Limestone	Water Bearing	*** Less than 50 gpm	Good
ORDOVICIAN			*Big Horn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	*** Less than 50 gpm	Poor to Fair
			Gros Ventre Formation	Non-Water Bearing		
			*Flathead Quartzite	Water Bearing	*** 50 - 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

2/ Parkman Sandstone member of Claggett may be water bearing.

M7-N-22914H

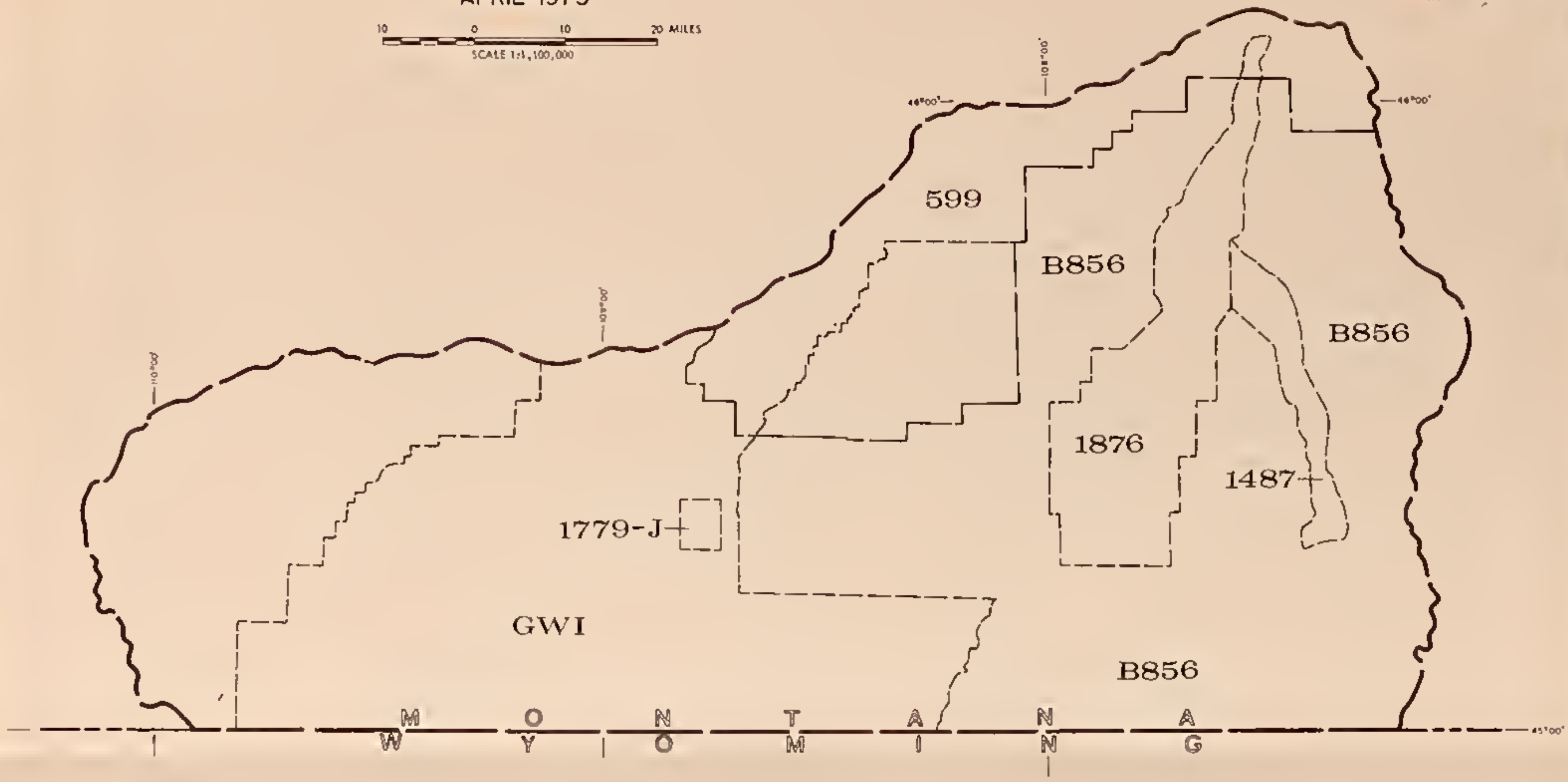
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

AREAS COVERED BY GROUND WATER REPORTS
WIND–BIGHORN–CLARKS FORK RIVER BASIN
MONTANA

APRIL 1973

U. S. DEPARTMENT OF AGRICULTURE

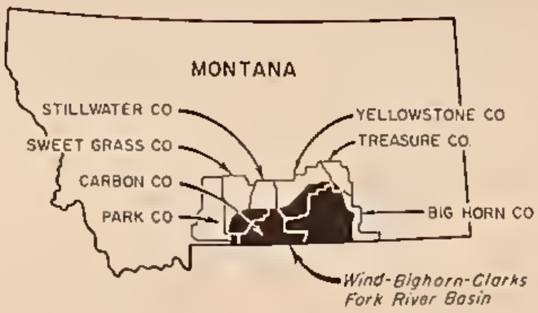
SOIL CONSERVATION SERVICE



BIBLIOGRAPHY OF GROUND WATER AND RELATED STUDIES

MONTANA

599	USGS Water Supply Paper 599, Ground Water in Yellowstone and Treasure Counties, Montana; G.H. Hall and C.S. Howard, 1929.
B856	USGS Bulletin 856. Geology of Big Horn County and the Crow Indian Reservation, Montana, 1935; W.T. Thom, Jr., G.M. Hall, C.H. Wegemann, and G.F. Moulton.
1487	USGS Water Supply Paper 1487, Geology and Ground Water Resources of the Lower Little Big Horn River Valley, Big Horn County, Montana; E.A. Moulder, M.F. Klug, D.A. Morris and F.A. Swenson, 1960.
1779-J	USGS Water Supply Paper 1779-J, Geology and Water Resources of the Bluewater Springs Area, Carbon County, Montana; E.A. Zimmerman, 1964.
1876	USGS Water Supply Paper 1876, Geology and Ground Water Resources of the Lower Big Horn Valley, Montana; L.J. Hamilton and O.F. Paulson, 1968.
GWI	Ground Water Inventory, Carbon County, Montana, Montana Water Resources Board, 1969.



LOCATION MAP

M7-E-22914H-N

concentration of salts for human and stock consumption. Aquifers beneath the shale usually have artesian pressure connected to recharge areas adjacent to the mountains. Consequently, wells may flow or have a small pump lift.

Large terraces adjacent to stream valleys are underlain by sand and gravel and often offer the opportunity for a shallow well or a spring development. Large yields are possible when conditions are favorable. Terrace material overlying shale, however, may contain a high concentration of salts derived from downward percolating water from precipitation and/or irrigation and impaired drainage.

Sandstones in the Wasatch, Fort Union, and Hell Creek Formations are lenticular and irregular. An average of 5 to 10 feet of sandstone exists per 100 feet of thickness in these formations. Wells located in these formations will encounter different geologic conditions; as a result, the ground-water potential of each well site requires individual evaluation. Map II-9 is generalized and does not show local detail.

FISH AND WILDLIFE HABITAT AND POPULATIONS

A variety of game habitat occurs in the Basin, ranging from rough alpine crags to vast grassland-sagebrush plains. Streams of varying size and gradient bisect this topography forming both narrow, steep-sided canyons and restricted alluvial valleys. Vegetative cover includes alpine growth, dense coniferous forests, typical semidesert shrub and grasslands, and dryland and irrigated farming.

Improved land management measures such as grassed waterways and water developments have provided wildlife with better habitat conditions. Timber harvest on forested lands often permits the improved growth rate and establishment of shrubs, forbs, and grass to provide increased forage. Controlled burning of areas is also of benefit as it eliminates many of the slash obstacles existing in a harvested area and improves the availability of nutrients for new plant growth. Fringes or strips of timber need to be left for wildlife cover and to improve snow-trap holding characteristics of the harvested areas.

Cropland throughout the study area has generally benefited small game. Breaking up of large habitat types for crop production has created additional "edge" and diversified habitat, especially on irrigated lands. The spreading of water on bottom and benchlands has created additional habitat for several species, especially pheasants, when cereal grains are involved. Some fur animals and white-tailed deer have benefited with river bottom irrigation. However, the use of "clean" farming techniques has been particularly destructive of willows, cover for deer and fur animals, on canals and drains and minimized these gains.

Deer are well distributed throughout the area. Both mule and white-tailed deer are common in most of their respective habitats. An exception is the Crow Indian Reservation where over-hunting has decimated deer populations, thus leaving much excellent deer habitat unused. See table II-10 and figure II-2.

TABLE II-10--ACRES OF BIG GAME RANGE AND GAME POPULATIONS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Game Species	Estimated Acres of Range	Estimated Population
Elk	1,087,000	600
Deer	4,989,000	22,000
Antelope	3,524,000	5,000
Moose	416,000	400
Bighorn Sheep	620,000	500
Rocky Mountain Goats	96,000	400
Bear	908,000	500

Sources: Acres of Range adapted from Missouri River Basin Framework Study; Population figures from Montana Department of Fish and Game. Wildlife habitat ranges are shown in figure II-2.

Elk, very popular but scarce big game animals, are scattered throughout the Beartooth and Pryor Mountains. Antelope continue to decrease as habitat is destroyed or degraded through land use change, fencing, and overgrazing. Moose, bighorn sheep, and Rocky Mountain goat populations are confined by their specialized habitat requirements to the mountainous portions of the subbasin.

Bear populations are low and their range more or less coincides with the mountain forest habitat. See figure II-2. A small portion of the southwestern part of the Beartooth plateau serves as habitat for the grizzly bear which is classified as a rare species. Because of incompatability between grizzlies and man, minimization of contact is necessary if we are to maintain populations of this rare animal.

Thinning overcrowded stands to increase growth and quality. USDA-FOREST SERVICE PHOTO

Debarking poles for use as fence posts--Custer National Forest. USDA-FOREST SERVICE PHOTO

Lodgepole corral. During the development of the West, lodgepole's highest use was for corrals and fences, but now it is used for power poles, woodpulp, and panels for interior finishing. USDA-FOREST SERVICE PHOTO

PLATE 4

Bull elk during rutting season in the high country.
SCS PHOTO 11-P1065-6

Bighorn ram on winter range.
SCS PHOTO

Two more trout to a limit. Farm pond in Big Horn County.
SCS PHOTO 11-P354-10

White-tailed deer are found along streams at lower elevations in the Basin.
USDA-FOREST SERVICE PHOTO

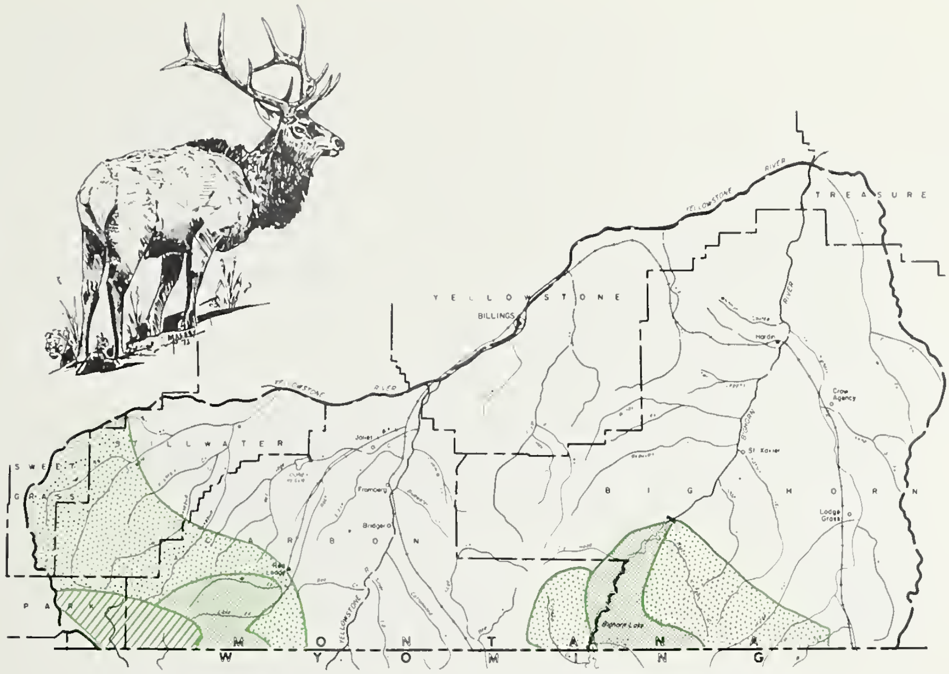
Snowshoe rabbit in summer coloration. USDA-FOREST SERVICE PHOTO

Foxes range from timbered uplands to open prairie.
USDA-FOREST SERVICE PHOTO

From Rock Creek valley to the alpine tundra over the switchbacks of the Beartooth Highway. USDA - FOREST SERVICE PHOTO

An alpine lake on the Beartooth plateau. USDA-FOREST SERVICE PHOTO

Big Bull Elk Canyon camp in Bighorn National Recreation area. BUREAU OF RECLAMATION PHOTO



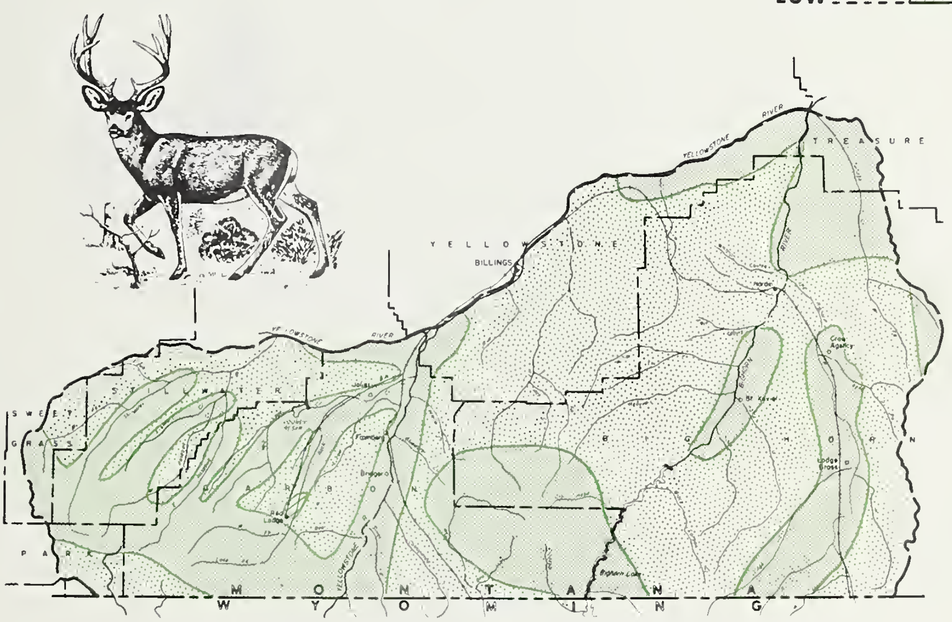
A. ROCKY MOUNTAIN ELK

HABITAT VALUE

HIGH

MEDIUM

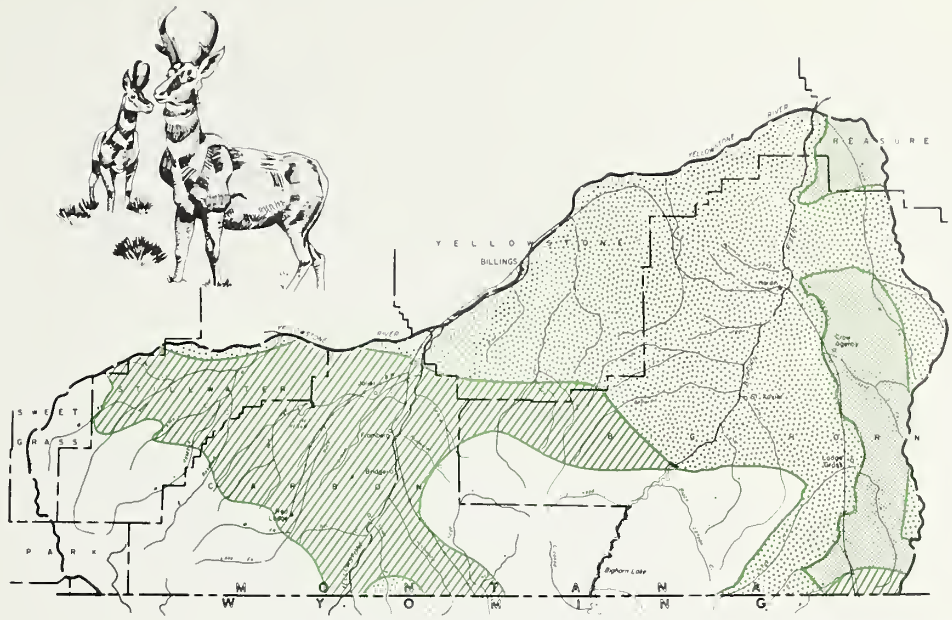
LOW



B. MULE & WHITE-TAILED DEER

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



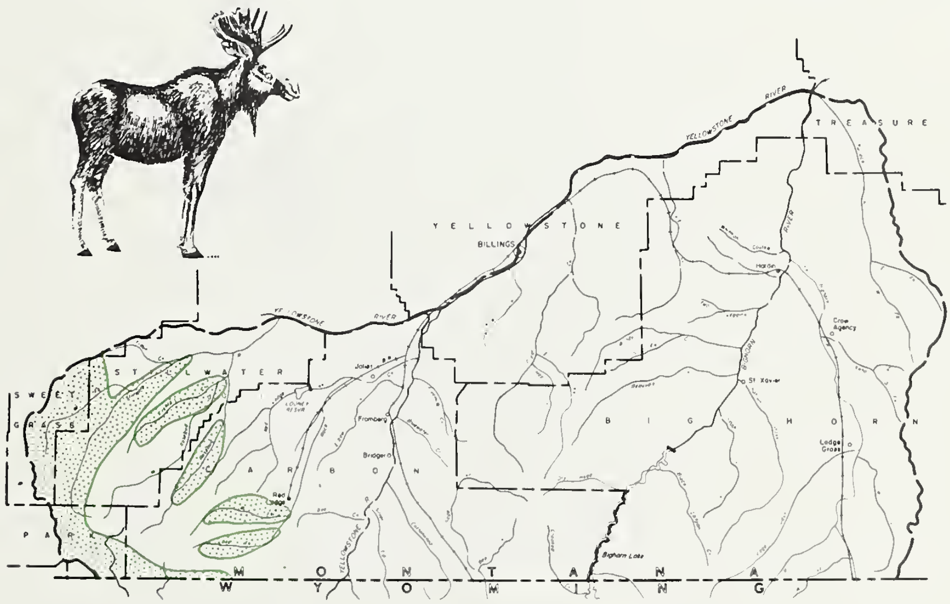
C. PRONGHORN ANTELOPE

HABITAT VALUE

HIGH

MEDIUM

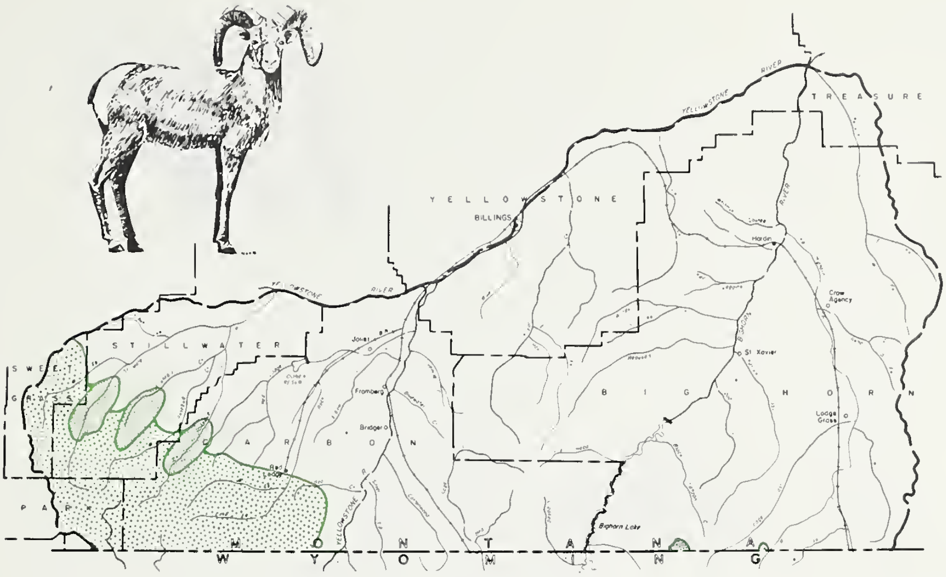
LOW



D. SHIRAS MOOSE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



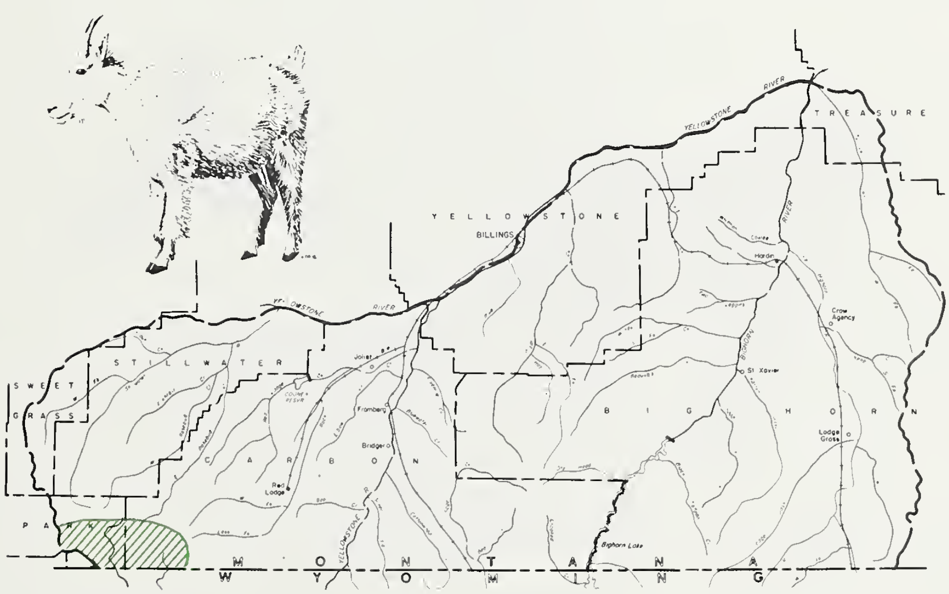
E. BIGHORN SHEEP

HABITAT VALUE

HIGH

MEDIUM

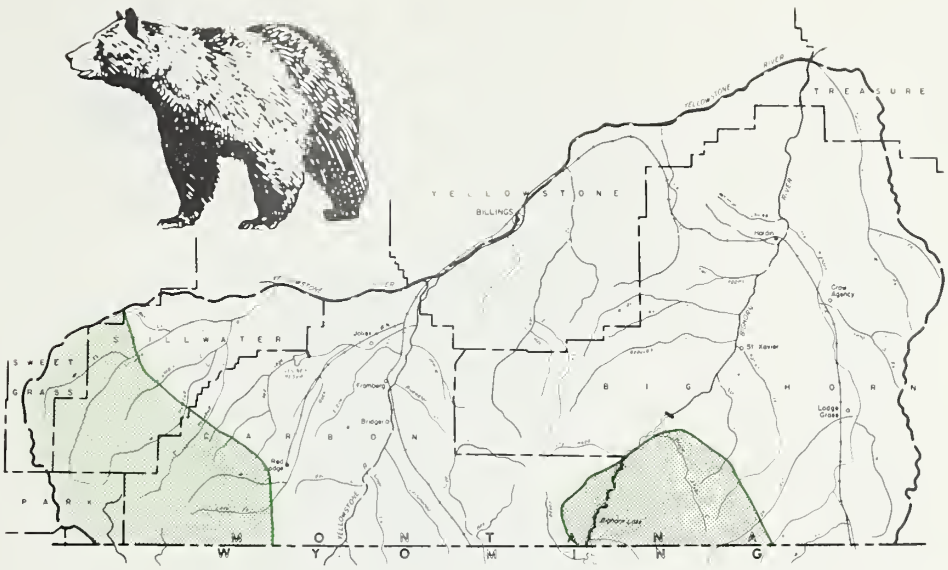
LOW



F. MOUNTAIN GOAT

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



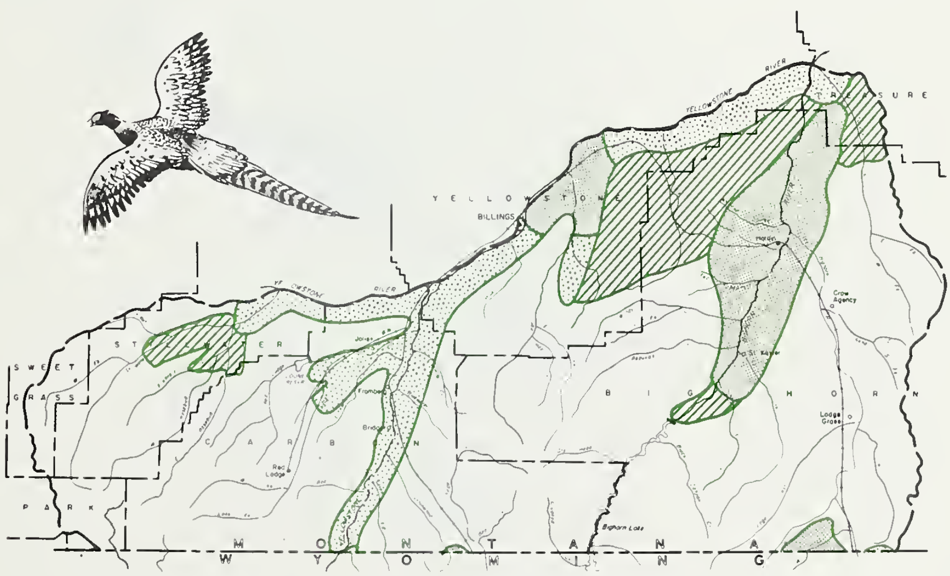
G. BEAR

HABITAT VALUE

HIGH____

MEDIUM__

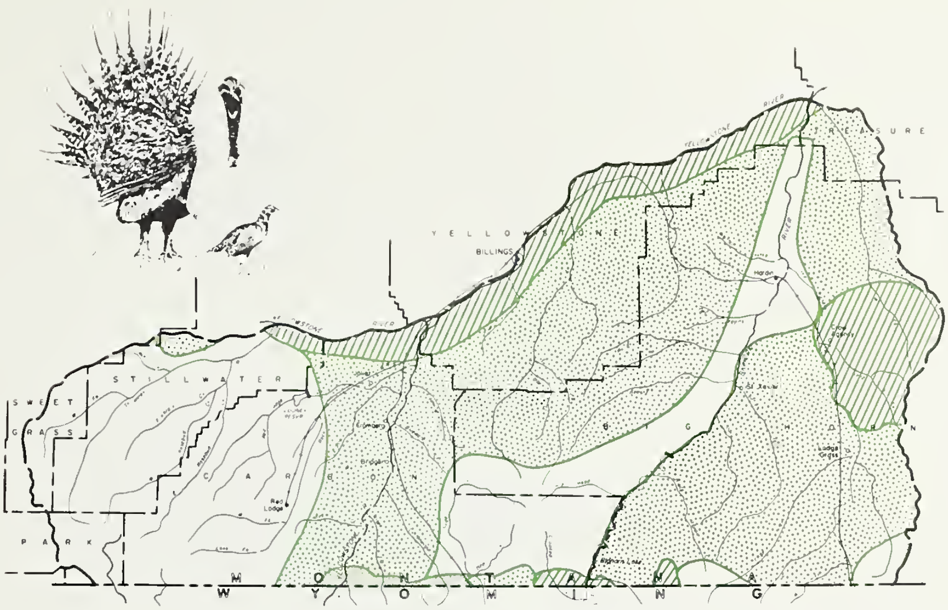
LOW_____



H. RING-NECKED PHEASANT

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



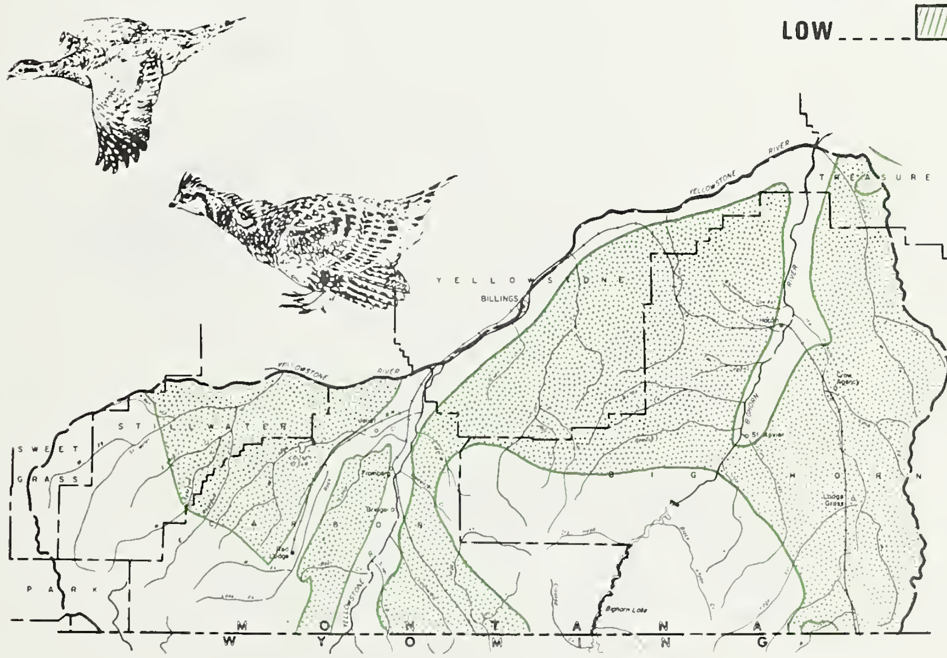
I. SAGE GROUSE

HABITAT VALUE

HIGH

MEDIUM

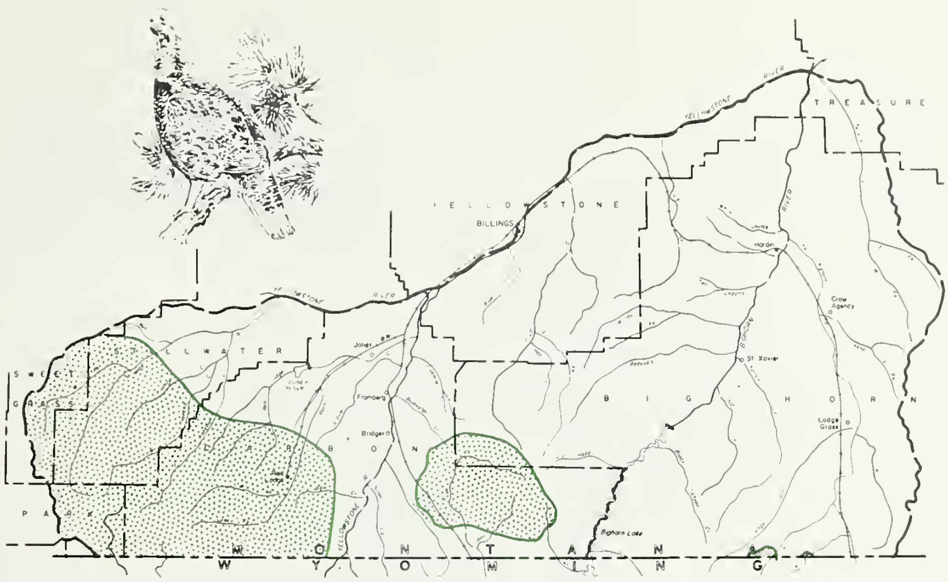
LOW



J. SHARP-TAILED GROUSE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



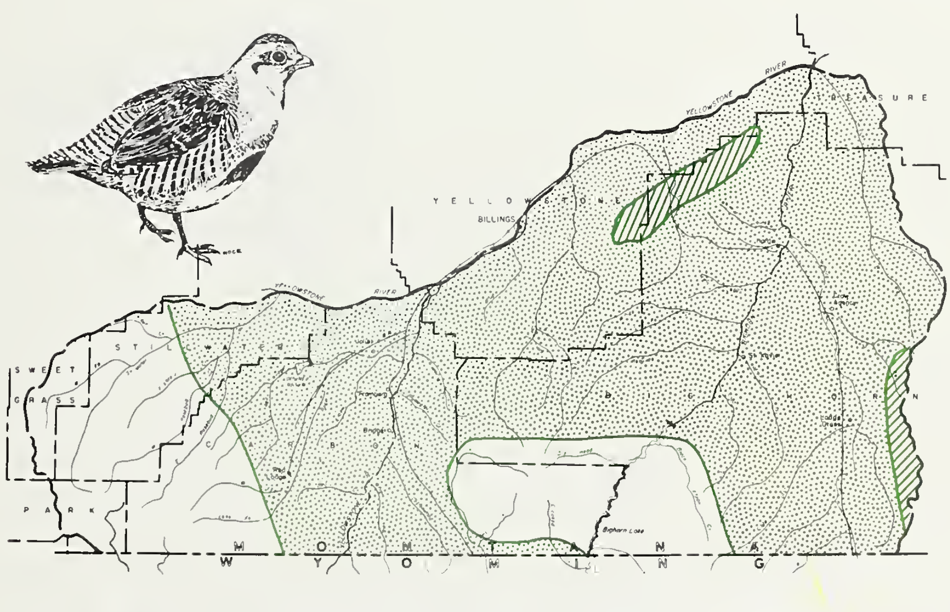
K. MOUNTAIN GROUSE

HABITAT VALUE

HIGH

MEDIUM

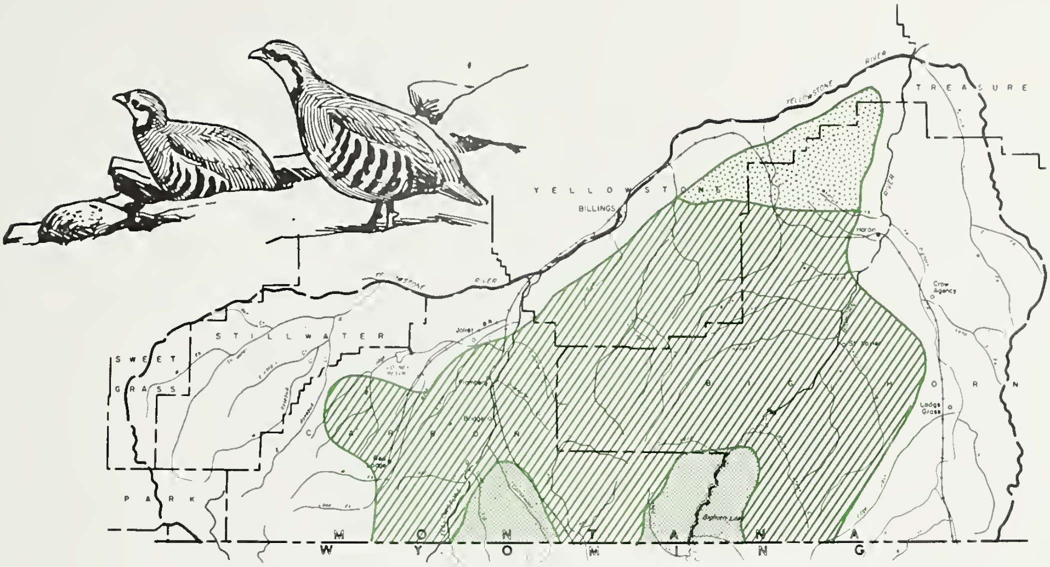
LOW



L. GRAY (HUNGARIAN) PARTRIDGE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



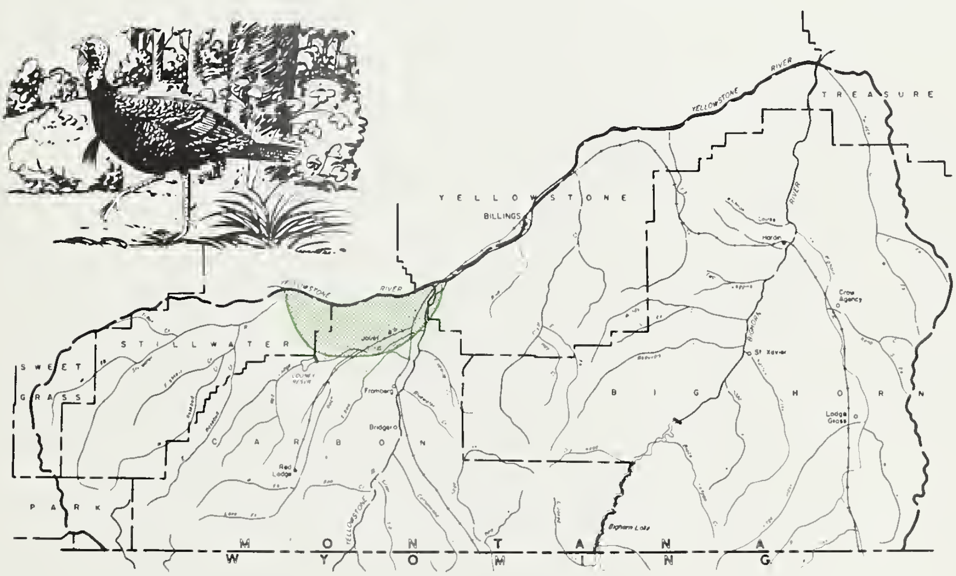
M. CHUKAR PARTRIDGE

HABITAT VALUE

HIGH ____

MEDIUM __

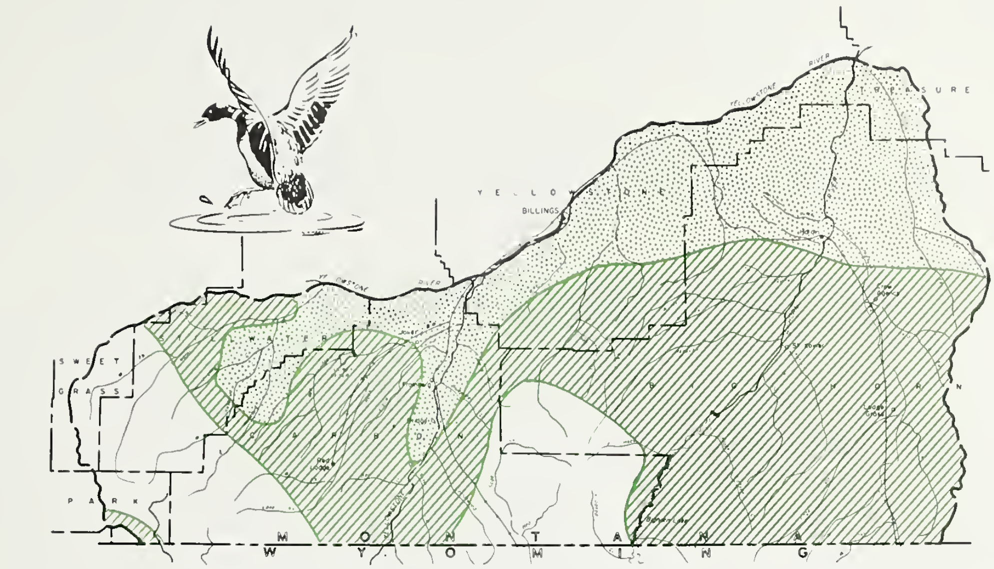
LOW _____



N. MERRIAM'S TURKEY

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study



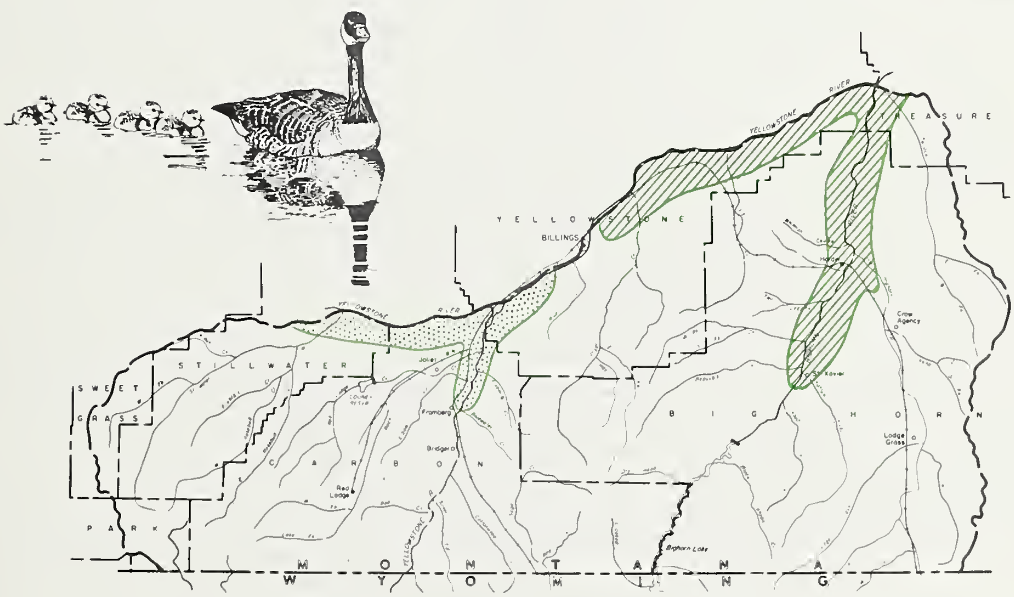
O. DUCKS

HABITAT VALUE

HIGH

MEDIUM

LOW



P. GEESE

FIGURE II-2 WILDLIFE HABITAT

Source: Adapted from Missouri River Basin Framework Study

Mountain lions are found throughout the river basin area and are most common in the timbered, mountainous regions. Their numbers fluctuate locally as food sources, mainly deer, fluctuate. Their far-ranging habits and territorial behavior preclude dense populations of lions.

Furbearing mammals in the Basin include coyote, bobcat, fox, jackrabbit, skunk, pine marten, canada lynx, beaver, muskrat, and raccoon. Skunk populations in recent years have been high. Mink, beaver, and muskrat are the major fur animals of value to the trapper.

Big game presently provide the greatest amount of recreational hunting in the Basin. The great variety of big game animals affords "quality" hunting opportunities. Over 80 percent of all licensed hunters seek deer. Presently, hunting success is very high. Antelope are utilized to the fullest extent possible and hunting success is high. Harvest control is being employed to maintain populations. Goats and bighorn sheep are in limited supply, but these species have increased slightly over the past few years. Due to licensing restrictions, only about 10 percent of the hunting for sheep and goats is by nonresidents. The moose kill is low, but moose hunter success has been relatively high in proportion to the few moose permits issued each year. Hunter success is often used as a gage of game populations. Bear hunting, for the most part, is in conjunction with other big game hunting, especially for elk.

Upland game birds hunted in the Basin include ring-necked pheasant, sage grouse, sharp-tailed grouse, and mountain grouse (blue, ruffed, and Franklin's), gray partridge, chukar, and wild turkey. Populations of all game birds have fluctuated markedly due to natural conditions.

Montana Department of Fish and Game surveys indicate that over 10,000 upland game birds are bagged each year with ring-neck pheasant and gray partridge comprising about 60 percent of the take. Sharp-tailed and sage grouse account for about 25 percent of the total bag.

Most upland game hunting is enjoyed by local hunters and "mixed bag" hunting is very common. Some seasons are arranged to provide opportunity to hunt more than one species during a single trip. Sage grouse harvests are generally restricted to small, accessible localities, with little or no hunting occurring in most of the more inaccessible areas. Chukar hunting promises to become more popular as this species becomes more widely distributed. Turkey populations are expanding and additional hunting opportunities may result. All of the upland game species are generally underutilized. Mourning doves are protected and cottontail populations remain virtually unutilized. See table II-11.

The coyote has been subject to almost continuous control programs, and the jackrabbit is hunted extensively as a night sport and for fur when populations are high. The low market value of all furs prevailing in recent years has greatly reduced public interest in trapping. Only

TABLE II-11--ACRES OF UPLAND GAME RANGE
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Game Species	Estimated Acres of Range
Ring-necked Pheasant	1,471,000
Sage Grouse	3,217,000
Sharp-tailed Grouse	2,840,000
Blue Grouse	1,030,000
Ruffed Grouse	1,030,000
White-tailed Ptarmigan	100,000
Gray (Hungarian) Partridge	3,742,000
Chukar Partridge	2,680,000
Merriam's Turkey	147,000
Cottontail Rabbit	3,000,000

Source: Adapted from Missouri River Basin Framework Study.

those landowners who incur damage from beaver, muskrat, mink, or raccoon, plus "hobby" trappers and a very few professional trappers exert any pressure on populations. Bobcats are hunted with dogs for sport and are commonly taken in predator control activities. The mountain furbearers, such as the marten, are rarely taken.

The complex of wetlands in the Basin from high mountain lakes with restricted summer use to low land lakes, reservoirs, stream habitat, irrigation canals and drains, stock ponds, and marshes are important to production of waterfowl.

The shortgrass prairies are becoming more suitable as waterfowl habitat areas because of land use changes on ranch lands. Each year, more and more ranchers are constructing stock ponds to trap spring runoff. These ponds are used extensively by waterfowl and other wildlife.

Waterfowl production in the prairie is dependent on the amount of precipitation that falls during winter and spring. Use escalates in those years that early spring moisture is adequate to fill stock ponds and natural depressions.

Excellent habitat for nongame birds exists throughout the Basin occupying about all vegetative zones. Most nongame birds in the area are classified as song birds and are protected by Montana law.

Trout streams in the Basin, particularly Rock Creek and the Stillwater River and its tributaries, are known for their high quality fishing. Other important fishing streams are the West Rosebud, East Rosebud, and the West Fork of the Stillwater. See table II-12 and map II-10. Many of the small creeks of the Basin provide good fishing as well. These waters have a variety of trout, the most common being rainbow and brown. Native cutthroat and brook trout are more common in the high mountain lakes and streams. New water areas of increasing importance to the angler are Bighorn Lake, its afterbay, and the Bighorn River from Yellowtail Dam to Hardin. This new fisheries addition provides excellent fishing for walleye, rainbow trout, brown trout, and lake trout.

Man-made impoundments and natural lakes provide excellent fishing opportunities for brook and rainbow trout. Additional impoundments are being built in the Basin, providing more fishing opportunities.

There are many mountain lakes on the 11,000-foot-high Beartooth plateau. These lakes provide a variety of excellent fishing. Many lakes are accessible only by foot, while others can be reached by horse or four-wheel drive vehicles. Back country lakes provide excellent fishing for cutthroat, brook, rainbow, and golden trout, in addition to grayling. See table II-13.

QUALITY OF THE NATURAL ENVIRONMENT

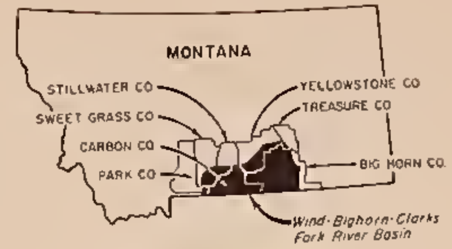
The scenic beauty of the Basin takes on many land forms from the barren shale badlands along the south slopes of the Pryors through timbered uplands to the alpine tundra of the Beartooth plateau. Most of this area is unspoiled by man because of its ruggedness and inaccessibility. Lower elevations may be characterized by desertic badlands, shortgrass prairie, or cultivated cropland depending on soil types and water availability. Increases in elevation lead one to increased vegetative cover with several species of trees to be found--various pines, firs, and Douglas-fir. Continuing upward on the land leads one to massive rock canyons in the western portion of the Basin topped by a large alpine tundra plateau. This is reached by the Cooke City highway. Many areas will require additional supervision as recreational pressures increase. The relatively low productivity of desert and tundra areas makes them more fragile than areas with higher rainfall and/or longer growing seasons. A desert shrub or a dwarf sub-alpine

TABLE II-12--SUMMARY OF STREAM MILES BY FISHERY CLASS 1/
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	Fishery Class 2/ 1	2	3	4	5	Total
	Miles					
Carbon	0	39	0	120	0	159
Stillwater	0	51	48	16	0	115
Sweet Grass	0	4	0	0	0	4
Park	0	6	0	0	0	6
Yellowstone	0	3	0	38	0	41
Big Horn	0	76	0	92	0	168
Treasure	0	0	0	3	0	3
TOTALS	0	179	48	269	0	496

1/ Source: Montana Department of Fish and Game

2/ Fishery classes are those set by the Bureau of Sport Fisheries and Wildlife as based on availability of access, esthetics, use, and productivity.
Class 1--Streams of national as well as statewide value.
Class 2--Streams of statewide value.
Class 3--Streams of value to large districts of the state.
Class 4--Streams of value to smaller districts such as counties.
Class 5--Streams of restricted value or not yet classified.



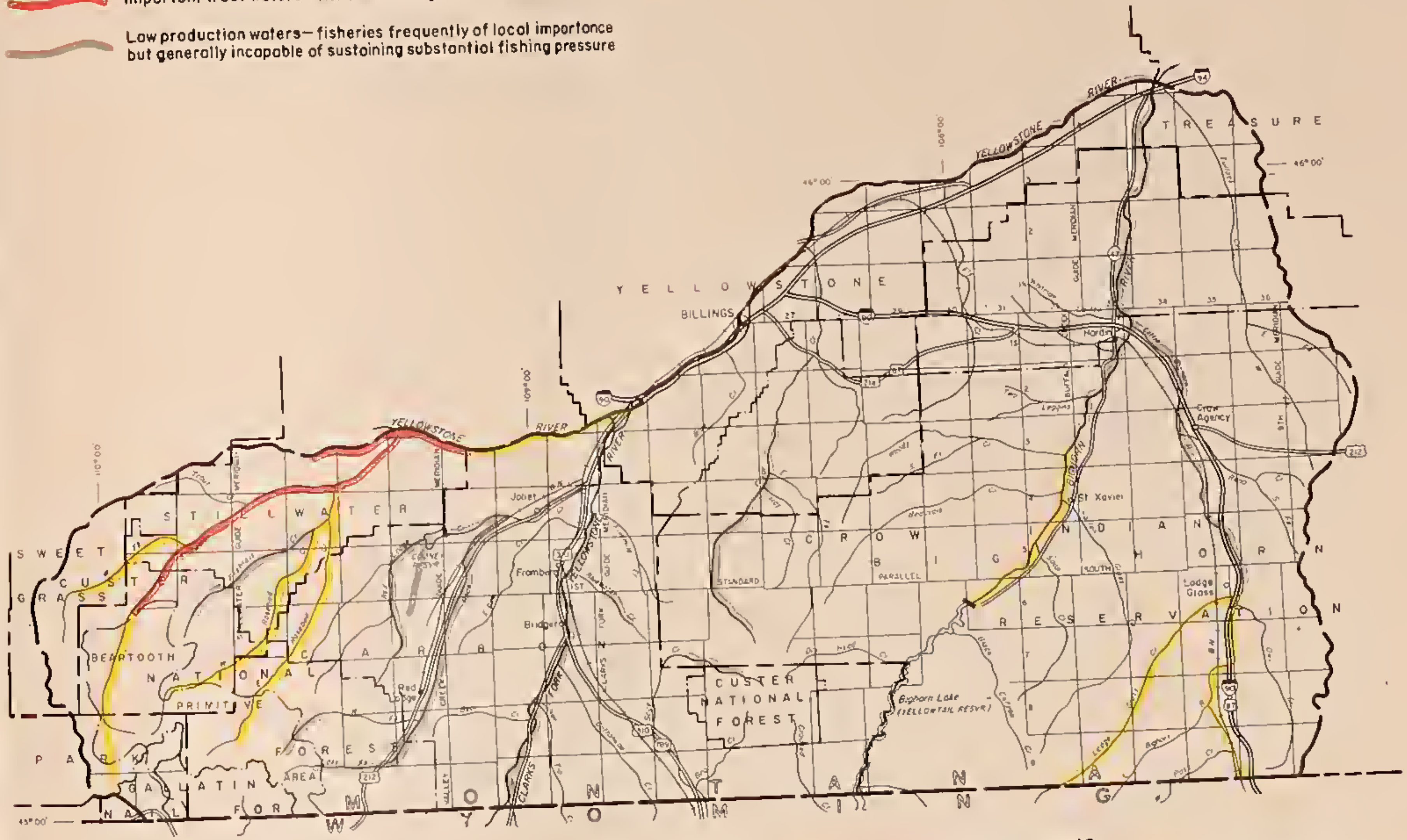
LOCATION MAP

STREAM FISHERY CLASSIFICATION

Very good trout waters–fisheries of statewide importance

Important trout waters–fisheries of regional importance

Low production waters–fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure



SOURCE
Bureau of Sport Fisheries and Wildlife
Montana State University
Montana Fish and Game Department

MAP II-10

STREAM FISHERY CLASSIFICATION

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES
SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914J

TABLE II-13--NUMBERS OF LAKES, RESERVOIRS, AND PONDS WITH FISHERIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	Natural Alpine Lakes	Alpine Reser-voirs	Natural Lowland Lakes	Lowland Reser-voirs	Farm Ponds Cold Water	Farm Ponds Warm Water	Total
	Number						
Sweet Grass					10		10
Park							
Stillwater	45	1	3		10		59
Carbon	77	1	3	1	27		109
Yellowstone					15	2	17
Big Horn				2	13	1	16
Treasure					6		6
TOTALS	122	2	6	3	81	3	217

Source: Montana Department of Fish and Game

tree may be several decades old and be no larger than a four-year-old seedling growing in a less severe environment. If it is once destroyed, renewal of such fragile desert or alpine vegetation through natural means may take several years to several generations.

The lack of industrial activity within the Basin contributes to its high environmental quality and attraction to outsiders. Water quality is quite variable, due primarily to differences in natural degradation such as erosion and salinity. Historic abuse of this area has contributed to erosion and saline return flows. A very low percentage of the total sediment production is attributable to any actions of man. In fact, total sediment yield has decreased because of land treatment, farm ponds, and reservoirs. Air quality is excellent, although transient pollution from nearby Billings has recently become noticeable. Low population density is one by-product of an economically inactive area which is enjoyed by Basin residents and visitors. However, these features may mean relatively little to those unemployed within the area. Scenery does not pay grocery bills.

RECREATIONAL RESOURCES

The recreational features of the Basin are great resources for meeting the increasing demands for wildland recreational activities.

Red Lodge, in southern Carbon County, is the starting point of the 11,000-foot-high Beartooth highway, winding its way to scenic Cooke City and the northeast entrance to Yellowstone National Park. The fact that an alpine vegetation type may be viewed from a passenger car, a relatively rare opportunity, is reason to consider designating this route a National Scenic Highway. Each summer, during the height of the tourist season, Red Lodge hosts the famous week-long Festival of Nations produced by the many nationalities in the area. Six miles west of town is the Red Lodge Mountain (previously called Grizzly Peak) Ski Area. Its triple chair lift provides skiers with a 2,000-foot gain in elevation to enjoy numerous runs.

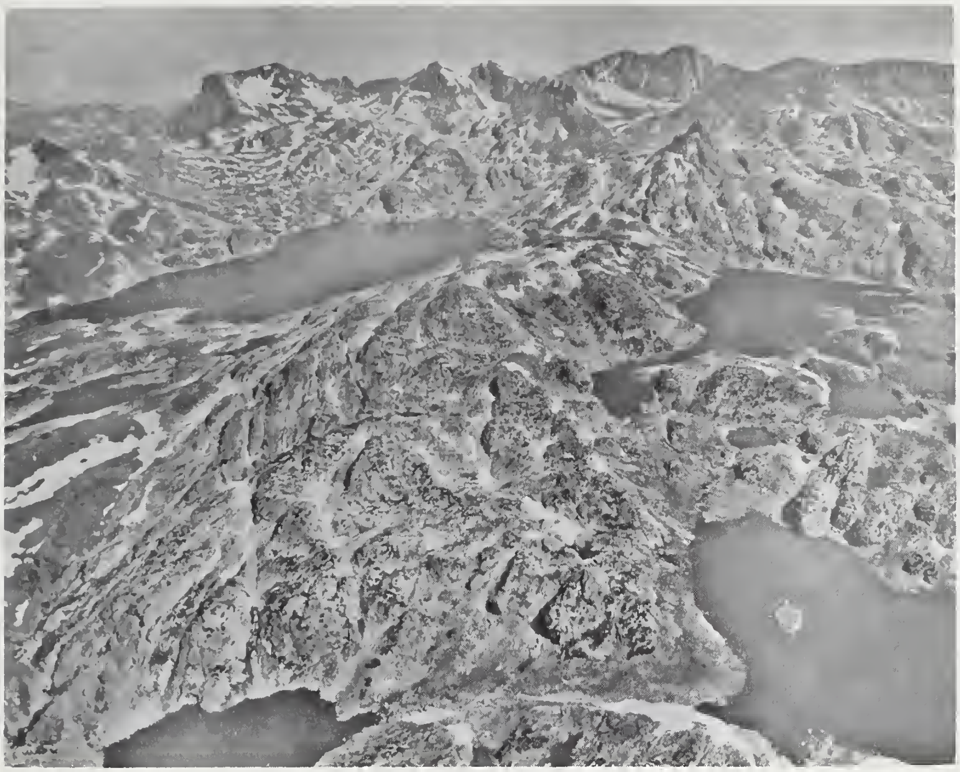
National Forest lands provide extensive recreational opportunities and a number of facilities. There are several camping and picnic areas in the various drainages of the Beartooth Mountains. Trailhead facilities are also provided in several places which further encourages wide use of the Beartooth Primitive Area. This is one of the few primitive areas where the user may have the rare opportunity to glimpse the grizzly bear. The use of the primitive area by recreationists provides employment for numerous outfitters and their hired hands. The attraction of these forest lands has led to increasing development of summer and retirement homes within the Basin area.

In the past, the Pryor Mountain area of eastern Carbon County has not been fully utilized because of inaccessibility. Most of this area is publicly owned and administered by the U. S. Forest Service, Bureau of Land Management, and National Park Service. The area has few camping and picnic facilities. Ice caves, limestone caverns, scenic overlooks, Indian vision quests, and Crooked Creek Canyon are some of the points of interest. This is a heavy use area for upland bird and deer hunting in the fall and snowmobiling in the winter.

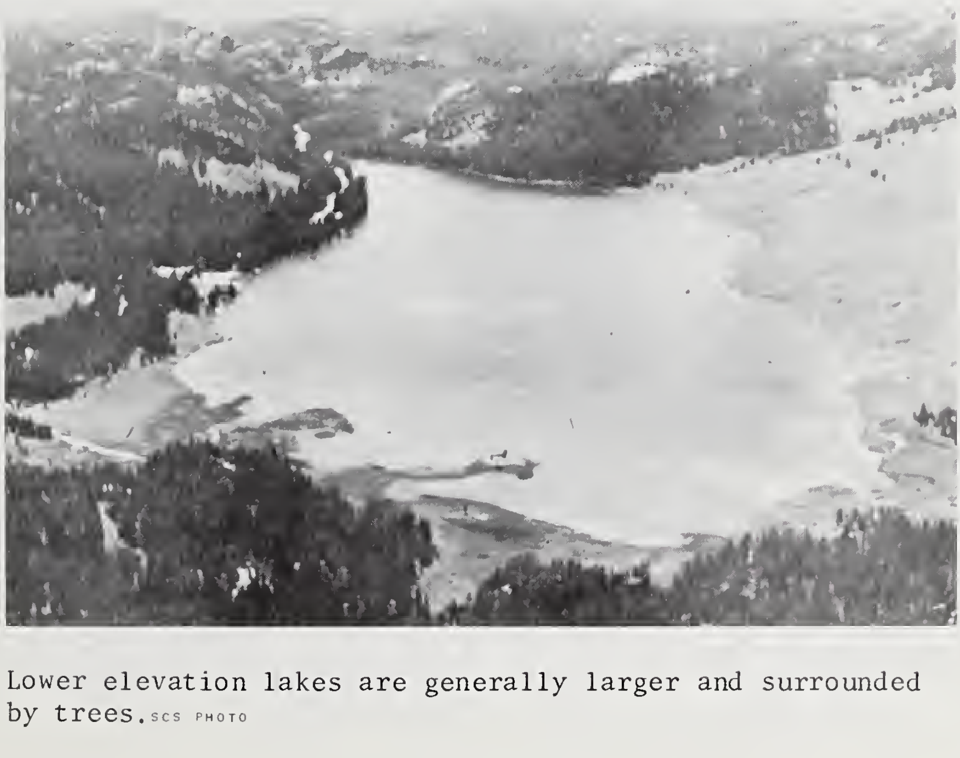
On the southern flank of the Pryor Mountains is Pryor Mountain Wild Horse Range with observation points to view the behavior of this once domesticated animal. The existence of this range is significant on a national scale as it is one of two formally recognized wild horse ranges in the country--the result of a national controversy. Bighorn Canyon National Recreation Area is a major attraction in the region. Its steep-walled canyon, hundreds of feet deep, was cut through by the Bighorn River, separating the Pryor Mountains to the west and the Bighorn Mountains to the east.

The Pryors provide a unique opportunity for the student of archeology, history, and lore of the old west. Studies indicate the area was inhabited by man more than 9,000 years ago. Chief Joseph traveled through the region when he was being pursued by the U. S. Army. This area is being studied for its archeological value and need for preservation.

The forested areas of the Basin are islands of green in a semiarid country. The varied recreational opportunities and wildlife of the forests and alpine regions attract large numbers of visitors and are important to the tourist industry. These forested areas are also important as local playgrounds and contribute significantly to the social and physical well-being of the people in the Basin.



High mountain lakes near Granite Peak are typical of higher elevations. USDA - FOREST SERVICE PHOTO



Lower elevation lakes are generally larger and surrounded by trees. SCS PHOTO

PLATE 8

Lake at the headwaters of Rosebud Creek. USDA-FOREST SERVICE PHOTO

Russell Lake--Beartooth Primitive Area. USDA-FOREST SERVICE PHOTO

PLATE 9

Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS

PLATE 11

Curious but spooky--inhabitants of the Pryor Mountain Wild Horse Range--where "jackrabbits have to carry lunches."

BUREAU OF LAND MANAGEMENT PHOTO

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

The first record of white man's entry into the Basin was made in 1743 when Chevalier de la Verendrye passed through this Indian territory in search of a route to the Pacific. The next white men came in 1804 in search of furs and gold. The Lewis and Clark Expedition journeyed down the Yellowstone River during the summer of 1806. The following year John Colter spent some time in the area drumming up fur trade for Manuel Liza, and in subsequent years the area was explored by many other fur traders and trappers. Other than these, very few white men saw the Basin until the trails were blazed by Jim Bridger and John Bozeman in 1864, linking the North Platte River with the Three Forks on the Missouri River. The Bozeman Trail crossed the Bighorn River at Fort C. F. Smith near the mouth of the Bighorn Canyon and proceeded northwesterly to the Yellowstone River around the north toe of the Pryor Mountains.

The Sioux, Crow, Shoshone, and Northern Cheyenne Indians resented the western incursion of settlers and the wanton slaughter of buffalo. A peace treaty was signed on Horse Creek near the mouth of the Bighorn River in 1851, but the history of the area was destined to be written in blood. The Indians were content with occasional isolated forays until 1863 when the Sioux went back on the warpath. This warfare continued until the government, forced to call a halt to the whole business, drew up the Fort Laramie Treaty of 1868 which relinquished all Indian claims to the lands east of the Bighorn Mountains and north of the North Platte River. The Sioux moved north and the stage was set for the crushing climax. The fight between the Sioux tribes and Custer's troops on June 25 and 26, 1876, was the climax of a series of battles fought earlier that year. The Custer Massacre on the Little Bighorn brought massive retaliatory action to end the Sioux wars. Fort Custer was established at the confluence of the Little Bighorn and Bighorn Rivers in 1877. Also in 1877, Chief Joseph and his Nez Perces made their famous retreat down the Clarks Fork River from the area of the present Yellowstone Park.

The 1868 treaty with the Crows at Fort Laramie set up the original reservation boundaries to include all land in Montana lying west of the 107th degree of longitude and south of the midchannel of the Yellowstone River. The 107th meridian is still the eastern boundary of the greatly reduced reservation.

In 1877 a small area of the reservation was set aside near Red Lodge for the development of coal. Mines were opened that year by the Rocky Fork Coal Company to produce coal for the Northern Pacific Railroad which had just been built along the Yellowstone River. The opening of the mines and railroad development brought the flood of

settlers who set up a clamor for opening the reservation for homesteads. Through a series of treaties the Indians ceded most of the western part of the reservation to the government and it was opened for settlement in 1892.

The northern area of the Bighorn Valley and lands along the Yellowstone River were ceded to the government in 1904 and were opened to homesteaders in 1906.

The first agricultural development came in the 1880-1890 decade with the influx of large cattle companies with herds as large as 30,000 head. Sheep raising had its beginning in 1901 when large company-owned flocks were brought into the area.

The first recorded appropriation of water in the Basin was made on April 1, 1881, near the mouth of the Clarks Fork River in Yellowstone County by John Young, Wilder M. Nutting, W. Bade, A. H. Mallory, L. A. Nutting, and L. Nutting for the purpose of milling, manufacturing, and irrigation. The water was to be diverted from the Yellowstone River. The first recorded development of water from streams within the Basin consisted of the Reno Unit of the Crow Indian Project in 1885 in Big Horn County. The first appropriation in Carbon County was made in 1891 by Irvin H. Will about seven miles south of Belfry on the Clarks Fork River. On August 1, 1893, M. E. Garrigus, M. F. Garrigus, and others made the first appropriation of Stillwater River water. After these earlier developments came a rash of water appropriations and ditch construction. The largest development was the Huntley Project which started in 1905 and was developed over the years to irrigate 28,143 project acres and 1,097 nonproject acres with water from the Yellowstone.

GENERAL DESCRIPTION

The population of the Basin in 1970 is estimated at 21,769 persons. Of this population, about 3,800 are Indians on or near the Crow Reservation. Other than for the reservation and the "bedroom-satellite" areas around Billings, the Basin is a population-losing area.

In order to provide meaningful information about economic activity and social characteristics of the area, published materials were utilized extensively. Data from secondary sources are generally not available for areas smaller than a county or a group of counties. Therefore, three counties believed to be representative of the Basin are used as the geographic unit for economic study. The three counties are Big Horn, Carbon, and Stillwater. Population, employment, and income are the more important economic indicators. These elements are described historically, measured in terms of present status and projected to 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, education, etc., are described and shown historically only.

Population

Population of the three-county study area declined from 1920 to 1930; increased about 600 persons during the 1930's, and then declined to the present time. The 1970 population count was 21,769. Only Big Horn County had an overall increase in population during the past 50 years. Part of the increase from 1950-60 occurred during the construction phase of Yellowtail Dam, followed by a population decrease after the dam was completed. There was a drastic loss of population in Carbon County following the closing of the coal mines after World War II. Other than for those fluctuations, the Basin has shown the steady population decline. Total population for the three counties is shown in table III-1. Basin residents are predominantly rural, although the population is becoming more urban-oriented. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most areas in the United States. In 1970, about 13 percent of the population in the three counties could be considered urban as compared to 11 percent in 1940. Hardin is the only town with sufficient population to qualify as an urban area. Population by rural and urban categories is shown in table III-2.

TABLE III-1--TOTAL POPULATION OF THREE MONTANA COUNTIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

County	1920	1930	1940	1950	1960	1970
Big Horn	7,015	8,543	10,419	9,824	10,007	10,057
Carbon	15,279	12,571	11,865	10,241	8,317	7,080
Stillwater	7,630	6,253	5,694	5,416	5,526	4,632
TOTAL	29,924	27,367	27,978	25,481	23,850	21,769

Source: U. S. Census of Population

In 1970 there was a total of eight incorporated places varying in size from 31 persons in Bearcreek to 2,733 in Hardin. In table III-3, incorporated places are shown according to their size class in 1970, thus revealing what changes have occurred since 1940.

The rural orientation of the area is also revealed by population density. There are about 2.4 persons per square mile in the three-county area as compared to 4.7 persons per square mile for the state of Montana

TABLE III-2--POPULATION BY RURAL AND URBAN CATEGORIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Category	1940	1950	1960	1970
Urban	2,950	2,730	2,789	2,733
Rural Farm	14,496	11,273	8,149	6,458
Rural Nonfarm	10,532	11,478	12,912	12,578
Total	27,978	25,481	23,850	21,769

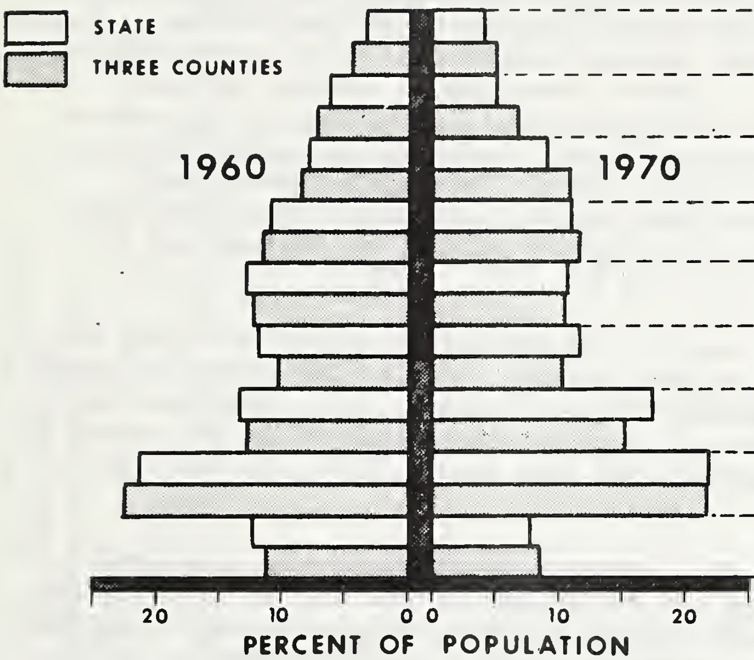
Source: U. S. Census of Population

TABLE III-3--POPULATION OF TOWNS BY SIZE CLASS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Size Class 1/	Number Of Towns	Year 1940	1950	1960	1970
Less than 500	3	1,333	1,014	880	807
500-999	2	1,622	1,390	1,511	1,523
1,000-2,499	2	3,912	3,827	3,559	3,017
2,500-5,000	1	1,886	2,306	2,789	2,733
Over 5,000	0	--	--	--	--
Total	8	8,753	8,537	8,739	8,080

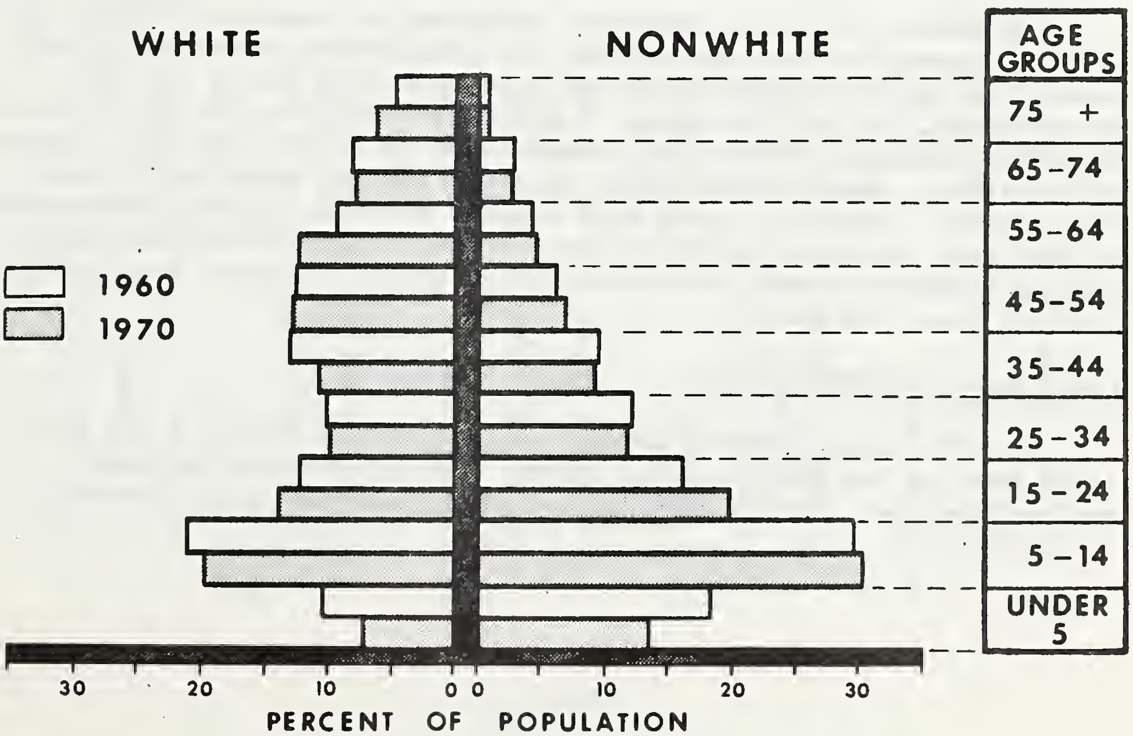
Source: U. S. Census of Population
1/ Population of towns in 1970 determined size class for all years shown above.

FIGURE III-1--PERCENT OF POPULATION BY AGE GROUPS, 1960 AND 1970 FOR THE STATE OF MONTANA AND MONTANA SUBBASIN WIND-BIGHORN-CLARKS FORK RIVER BASIN



AGE GROUPS	% CHANGE 1960-70	
	3 CO'S	STATE
75 +	+16.9	+33.4
65-74	-11.7	-9.7
55-64	+17.3	+21.6
45-54	-6.7	+6.2
35-44	-23.9	-12.8
25-34	-9.1	-0.9
15-24	+8.4	+34.9
5-14	-11.8	+4.7
UNDER 5	-33.5	-31.4

FIGURE III-2--PERCENT DISTRIBUTION OF POPULATION BY AGE GROUPS AND BY RACE, 1960 AND 1970, MONTANA SUBBASIN



and 57 persons per square mile for the United States. Big Horn County contains most of the Crow Reservation. Currently, 18 percent of the total population and 20 percent of the rural people are Indian. The number of Indians increased from 3,455 in 1960 to 3,969 in 1970. Nearly 96 percent live in rural areas.

From 1960-70 migration patterns have influenced population changes in the study area by a greater amount than birth and death rates. During this decade each of the three counties experienced a net out-migration for a total of 4,165 people. Shifts from farm to nonfarm residency were mentioned earlier; consequently, out-migration has had a profound impact on the number of people on farms. Off-farm employment opportunities, coupled with decreased agricultural labor requirements and increased efficiency in other farm inputs, have resulted in few rural inhabitants. Net migration rates for the past three decades are shown in table III-4.

Numerous side effects result from population migration. Some age groups are influenced more so than others. A large proportion of those who migrate come from the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of area and state populations from 1960 to 1970 are shown in figure III-1.

The Indian population as a whole is quite young when compared to the non-Indians. The median age of Indians in the area in 1970 was 20 years as compared to 31 years for all inhabitants. More than 63 percent of the Indian population is under 25 years of age as contrasted to 41 percent for the non-Indian population. The difference in age composition between whites and nonwhites (primarily Indians) is shown in figure III-2 and table III-5.

The amount of formal education completed is somewhat variable between segments of the population. In 1960 median school years completed for persons 25 years old and over were 10.0, 10.0, and 8.5, respectively, for all residents, rural farm residents, and the nonwhites. By 1970, comparable educational levels were 11.7, 12.1, and 10.0 years, respectively. Nearly every small town has its own grade school and high school. There are seven high schools in Carbon County alone--some of them only six or seven miles apart. Some consolidation for better quality education seems desirable, but as yet no workable or acceptable plan has been presented.

Labor Force and Employment

In 1970, approximately 50 percent of those 16 years of age and older made up the Basin's labor force. The labor force includes employed persons as well as those currently unemployed but seeking

TABLE III-4--COMPONENTS OF POPULATION CHANGE
(1940-1970) FOR THREE COUNTIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Component	Big Horn		Carbon		Stillwater		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1940 Population	10,419		11,865		5,694		27,978	
1940-50:								
Natural Increase[1/]	1,508		546		380		2,434	
Net Migration[2/]	- 2,103	-20.2	- 2,170	-18.3	- 658	-11.6	- 4,931	-17.6
Population Change	- 595		- 1,624		- 278		- 2,497	
1950 Population	9,824		10,241		5,416		25,481	
1950-60:								
Natural Increase[1/]	2,147		608		712		3,467	
Net Migration[2/]	- 1,964	-20.0	- 2,532	-24.7	- 602	-11.1	- 5,098	-20.0
Population Change	183		- 1,924		110		- 1,631	
1960 Population	10,007		8,317		5,526		23,850	
1960-70:								
Natural Increase[1/]	1,824		114		146		2,084	
Net Migration[2/]	- 1,774	-17.7	- 1,351	-16.2	-1,040	-18.8	- 4,165	-17.5
Population Change	50		- 1,237		- 894		- 2,081	
1970 Population	10,057		7,080		4,632		21,769	

Source: U. S. Census of Population

1/ Births to resident mothers minus deaths of residents.

2/ Population change minus natural increase.

TABLE III-5--PERCENT DISTRIBUTION OF POPULATION BY AGE GROUPS AND BY RACE (1960 AND 1970) WIND-BIGHORN-CLARKS FORK RIVER BASIN (Montana)

Age Group	Whites		Non-White	
	1960	1970	1960	1970
	Percent			
75+	4.5	6.1	.9	0.6
65-74	7.9	7.9	2.9	2.8
55-64	9.2	12.3	4.2	4.8
45-54	12.4	12.8	6.1	7.0
35-44	12.8	10.5	9.5	9.2
25-34	10.0	9.9	12.3	11.9
15-24	12.0	13.9	16.2	19.9
5-14	21.1	19.6	29.5	30.2
Under 5	10.1	7.0	18.4	13.6
TOTAL	100.0	100.0	100.0	100.0

Source: U. S. Census of Population

employment. A major portion of the labor force is in the 25-64 age group. This age group is gradually becoming a larger part of the total because there is a tendency for young workers to delay their entry to the labor force because of educational opportunities and job training requirements. Also, improved retirement benefits have attracted older workers to withdraw from the labor force.

The 5.0 percent unemployment rate of the Basin area is comparable to the national average. There are numerous workers whose labor is underutilized, thus their income is less than it might be. Underemployment differs from unemployment only in that human resources are utilized to some extent. An unemployed person cannot find work while an underemployed individual can find work, but at an amount less than he desires. One cause of underemployment is hidden because some people do not look for jobs. If there is a lack of employment opportunities, they withdraw from the labor force and are not counted as unemployed. Another cause is the immobility of people, especially those above 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the Basin area also add to this situation. Fishing and hunting are not readily sacrificed for added income. Also, many jobs are seasonal, leaving people unemployed or underemployed part of the year. Farming, food processing industries, mining, and recreation may provide only seasonal employment. The tourist trade is most heavily concentrated in the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine if incomes are below capacity. County income capacities are measured by age, educational status, and other selected attributes of the labor force. They are compared with similar conditions for the nation as a whole. In 1960, Basin underemployment rates were 24 percent of the male labor force and 28 percent of the female labor force for a combined 25 percent of the total labor force. Severe underemployment exists at 20 percent or over.

It should be noted that in 1940, men accounted for 87 percent of all employees and only 71 percent by 1970. Meanwhile, the number of women employed nearly doubled. One reason for increased female participation is that farm women generally have not been counted as a part of the labor force, even though they may contribute significantly to agricultural output. However, as farm women seek off-farm employment, or as they migrate off farms and obtain jobs, they are counted in the labor force and in total employment. Another reason is the tendency for women who have finished rearing their families to find jobs in service-type industries. More of these jobs are becoming available and quite often they can be filled by female workers with very little specialized training.

Some other reasons for the increasing ratio of women to men in the labor force might be that many jobs that have been lost were of the type that would attract a male head of a household, while many of the new jobs may be of the type that do not provide full family support on the wages paid. Out of necessity, both head of household and nonhead of household women may be willing to accept these positions to augment substandard income levels. In addition, the increased number of women workers may be in part a function of age and "free" time as their family responsibilities lessen. This latter type of increased competition for employment will likely encourage out-migration of the area by younger workers.

Employment and ages of non-Indian workers are typical for agriculturally-oriented areas. There is a small carpet manufacturing plant and a new recreation complex at Crow Agency that has changed the employment pattern of some of the Indians. The low longevity and high birth rate among the Indians produce an age distribution on the reservation much different from the pattern of the rest of the Basin. See figure III-2.

The decline of population from 1940 to 1970 was closely related to fewer farm employment opportunities. Total employment decreased 17 percent during the period while agricultural employment declined 60 percent, table III-6. It should be noted that employees of agriculturally-related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

TABLE III-6--EMPLOYMENT BY INDUSTRY
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Industry	1940	1950	1960	1970	Percentage Change 40-50	50-60	60-70	Percentage Distribution 1960	1970
	Number								
Agriculture & Forestry	4,975	4,366	2,844	1,990	-12.3	-34.9	-30.0	36.2	28.1
Mining	306	226	258	54	-26.2	+14.2	-79.1	3.3	0.8
Construction	290	450	459	404	+55.2	+ 2.0	-12.0	5.9	5.7
Manufacturing	195	206	363	528	+ 5.6	+76.2	+45.5	4.6	7.5
Food Prod.	(101)	(99)	(143)	(180)	- 2.0	+44.4	+25.9	NA	NA
Lumber Prod.	(44)	(28)	(55)	(53)	-36.4	+96.4	- 3.6	NA	NA
Other Mfg.	(50)	(79)	(165)	(295)	+58.0	+108.9	+78.8	NA	NA
Transportation, Comm. & Utilities	271	416	486	382	+53.5	+16.8	-21.4	6.2	5.4
Wholesale Trade	94	99	88	145	+ 5.3	-11.1	+64.8	1.1	2.0
Retail Trade	839	1,127	1,117	1,264	+34.3	- 0.9	+13.2	14.2	17.8
Finance, Insurance & Real Estate	68	97	157	186	+42.6	+61.9	+18.5	2.0	2.6
Services	1,115	1,131	1,428	1,682	+ 1.4	+26.3	+17.8	18.3	23.7
Government	272	334	379	450	+22.8	+13.5	+18.7	4.8	6.4
Not reported	87	158	268	0	+81.6	+69.6	NA	3.4	NA
Total	8,512	8,610	7,847	7,085	+ 1.2	- 8.9	- 9.7	100.0	100.0
Male	7,397	7,006	5,841	4,996	- 5.3	-16.6	-14.5	75.6	70.5
Female	1,115	1,604	2,006	2,089	+43.9	+25.1	+ 4.1	24.4	29.5
Montana	185,564	220,468	237,598	244,608	+18.8	+ 7.8	+ 3.0	Not Applicable	

Source: U.S. Census of Population

Basic industries of the area include agriculture, forestry, mining, railroad transportation, interstate highway construction, and manufacturing. In 1940, they provided 64 percent of all jobs; by 1970, only 36 percent. A sizeable increase in manufacturing jobs somewhat dampened a further decline. Agriculture and mining are the only major industries in which employment declined steadily for the 30-year period. During the 1940's, sizeable increases in employment were noted in the construction, transportation, communication, utilities, retail trade, finance, insurance, and real estate sectors. Except for retail trade, employment continued upward in these sectors during the decade of the 1950's. Along with agriculture and mining, construction, transportation, communications, and utilities sectors declined in employment between 1960 and 1970.

Economic activity in the business and manufacturing sectors is shown in table III-7. Trends in the number of establishments vary by industry. Incomplete reporting of the dollar value of business activity somewhat obscures any trends. In 1969, 2.7 million barrels of crude oil were produced in the three-county area.

Income

Another measure of well-being in an area is personal income. Total personal income for residents of the three-county area increased from 14 million dollars in 1940 to 51 million dollars in 1968 for an increase of 272 percent, table III-8. Meanwhile, total personal income for the nation rose 775 percent. The heavy reliance upon farm earnings as a source of income has affected the overall rate of growth. Per capita income also rose slightly during the period; however, in 1968 it was 28 percent below the national average.

Personal income normally increases over time for two reasons. The first is increasing production, which implies rising income. The second source is price inflation. It is important to distinguish between the two influences because the latter can exaggerate the growth of income. Inflation is reflected in rising prices of goods and services, as well as in increased money income to individuals, businesses, and government. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation. Total personal income after adjustment to a 1967 dollar base, is also shown in table III-8. Income per family in the Basin is lower than that for Montana as a whole. The most significant comparison is that 21.4 percent of the families in Big Horn County and 14.3 percent in Carbon County in 1969 had incomes of less than the poverty level (as defined by the census) as compared to about 10.4 percent in this category for all of Montana. Yellowstone County had about 9.4 percent and Stillwater County 12.5 percent of their families in this poverty level category. Data for Yellowstone County are influenced largely by Billings, while data for Stillwater County may be

TABLE III-7--NUMBER OF BUSINESS ESTABLISHMENTS AND REPORTED ECONOMIC ACTIVITY (1958-67) FOR THREE COUNTIES WIND-BIGHORN-CLARKS FORK RIVER BASIN (Montana)

Item	Unit	1958	1963	1967
Wholesale Trade:				
Establishments	No.	48	40	36
Sales	$Million	7.5	11.4	11.5
Retail Trade:				
Establishments	No.	346	324	272
Sales	$Million	21.8	27.4	26.5
Selected Services:				
Establishments	No.	131	138	118
Receipts	$Million	1.5	2.0	1.8
Mineral Industries:				
Establishments	No.	28	41	21
Value of Shipments and Receipts	$Million	12.1 1/	9.3 1/ 2/	N.A.
Manufacturing:				
Establishments	No.	23	22	17
Value Added	$Million	.320 2/	.51 2/	.4 1/ 2/

Current Dollars

Source: U. S. Census of Business; U. S. Census of Manufactures.

1/ Data for Stillwater County have been withheld to avoid disclosure of individual firms.

2/ Data for Big Horn County have been withheld to avoid disclosure of individual firms.

TABLE III-8--PERSONAL INCOME AND EARNINGS BY BROAD INDUSTRIAL SECTOR FOR SELECTED YEARS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Category	1940	1950	1959	1966	1968	1970
			Thousands of Dollars 2/			
Total Personal Income	13,716	35,728	40,113	48,511	51,098	60,604
Per Capita Income 1/	492	1,397	1,696	2,006	2,133	2,784
Per Capita Income rel. to U.S.=100	83	93	78	68	62	71
Total Earnings	12,308	31,296	32,337	38,593	38,954	44,457 4/
Farm Earnings	7,213	19,229	13,868	14,383	12,692	14,413
Total Nonfarm Earnings	5,095	12,067	18,469	24,210	26,262	30,044 4/
Govt. Earnings	1,833	2,845	5,446	8,879	9,835	12,242
Private Nonfarm Earnings	3,262	9,222	13,023	15,331	16,427	17,802 4/
Manufacturing	127	391	598	699	1,077	2,684
Mining	268	808	1,989	1,149	1,260	895
Contract Con.	255	1,001	1,111	2,426	1,836	891
Trans., Comm. & Public Utilities	383	1,000	1,670	1,868	2,221	2,286
Wholesale & Retail Trade	1,511	4,169	4,939	5,245	5,415	5,401
Finance, Ins. & Real Estate	106	321	608	941	1,054	1,120
Services	612	1,506	1,952	2,749	3,272	3,583
Other	--	26	156	254	292	313
			Thousands of Dollars 3/			
Total Personal Income	34,462	49,280	45,325	49,755	49,322	53,632
Per Capita Income 1/	1,232	1,934	1,916	2,057	2,060	2,464

Source: Office of Business Economics Information System.
1/ Per Capita Income is shown in dollars.
2/ Current dollars.
3/ 1967 constant dollars.
4/ Includes $629,000 of manufacturing and Contract Construction earnings (Stillwater County) not shown separately to avoid disclosure.

influenced by large wheat farms and more well-to-do retirees along the Stillwater River. In Big Horn County, 32 percent of rural nonfarm families have below poverty level incomes. This is the second highest such incidence in the state and is largely influenced by the rural Indian population on the Crow Reservation.

Earnings (wages, salaries, other labor income, and proprietor's income) account for about 73 percent of total personal income in the area. Total earnings are shown by major sectors in table III-8. In 1940, farm earnings were 59 percent of the total and then declined to 32 percent in 1970. The next most important source of basic income is from minerals and petroleum. There is no commercial fishing and only a minor forestry industry. Although the local income is significant, total income from tourism and employment in services to tourists has not been separated from services to agriculture and other sectors of the economy. Income from manufacturing is small and has declined further with the closing of the sugar refinery at Hardin. Heavy construction consists almost entirely of highway building, but in the near future it may involve construction of water conduits or industrial plants to support development of the coal fields of southeastern Montana and northeastern Wyoming. Such construction employment is fundamentally transient in nature and provides a poor basis for Basin development.

Urban Centers and Transportation

There are no urban centers within the study area; however, Billings exerts considerable influence in the economy of the Basin by providing a cultural center and principal market outlet for agricultural products. It also lends stability to the surrounding area by providing some off-season employment opportunity for farmers and a seasonal labor supply of high school and college youth. The economy of Billings is largely dependent on agriculture, but is stabilized with a sound basic petroleum industry, wholesale outlets, small manufacturing, and transportation industries.

There are community hospitals at Red Lodge, Columbus, and Hardin, with more complete medical facilities at Billings. Most of the towns and some farms use natural gas and electricity supplied by the Montana Power Company. The rest of the Basin is served by rural electric cooperatives. Most farm and town residences have telephone service. Interstate Highways 90 and 94 are still under construction in the Basin. Other highways include U. S. 87, 212, and 310, and State Highways 312, 212, 47, 416, 789, 397, 308, 307, 421, 425, 419, and 420. In addition to highways, the main line of the Burlington Northern Railroad crosses the north end of the Basin and two branch lines of the Burlington Northern traverse the Basin from north to south through Hardin and through Bridger with a spur extending to Red Lodge. There is no scheduled airline service in the Montana part of the Basin, but several airlines serve Billings on regular schedules.

Projections

Total employment and population in the three-county study area are projected to decrease through 2020. The decrease in employment will occur in the agricultural sector with little change in the remaining sectors. Agricultural employment is projected to be 1,550 in 1980; 1,200 in 2000; and 1,100 in 2020. This is a decrease of over 40 percent from 1970 to 2020.

Total population in the three-county area is projected at 19,000 by 2020. This is a decrease of about 15 percent from the 1970 population. Population projections are based upon employment participation rates. By 2020, it is estimated that the population of the nation will more than double. Estimates of per capita income for the projection period are also shown in table III-9.

TABLE III-9--PROJECTED POPULATION, EMPLOYMENT, AND PER CAPITA INCOME
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Item	1970	1980	2000	2020
Population	21,769	20,500	19,500	19,000
Rural Farm	6,458	5,200	4,600	4,300
Employment	7,085	6,700	6,400	6,300
Agricultural	1,990	1,550	1,200	1,100
Other Basic	582	600	600	600
Nonbasic	4,513	4,550	4,600	4,600
Per Capita Income 1/	2,464	3,100	6,100	11,500

Source: OBE Data and Census Data adjusted to local conditions.
1/ 1967 dollars

When all these economic elements are aggregated, a less than encouraging picture of the study area emerges. Population and employment have been declining and probably will continue to decline. The historic economic base of the area will continue to change, showing an increasing dependency of the area on external demand factors to sustain

economic activity. Because agricultural activity will continue to be dominated by livestock production, the rate of decrease in agricultural employment should decline and eventually stop. However, the secondary economic impact of the agricultural industry may decrease as farm sizes and incomes increase because these larger units will find it more attractive to acquire more goods and services outside the Basin area.

The above projections reflect an extension of historical trends occurring in major sectors of the area economy. Very recent developments in the mining industry may alter the projections considerably. Large deposits of coal are known to exist throughout southeastern Montana, including the eastern part of Big Horn County. The total resource is estimated at many billions of tons, much of which is recoverable through strip-mining methods. Current annual production is small in relation to the total resource. Production is increasing rapidly and the potential for further development is very good if large quantities of water are delivered to the coal fields.

In order to maintain the level of economic activity, elements other than the traditional economic base will have to increase. Examples include provision of services to part-time and nonresidents of the area pursuing leisure-time activities there. There may also be some spillover effect from the coal development expected east of the Basin. Another spinoff of this latter item may be that many people employed in the coal development will come into or through the Basin to seek recreation.

Manufacturing may continue to expand, but future growth would have to far exceed past growth in order to absorb declining employment from the other sectors. This is not likely to occur, however, due to the locational disadvantage experienced by any large manufacturer. It may be possible to compensate for this with an available labor supply that would accept less-than-average pay scales, lower at-site power costs, or governmental subsidization.

It should be noted that increased employment has been largely in secondary economic industry to service the economic base. This has been a trend nationwide of even greater magnitude. Because of the number of poverty-classified families and the declining relative position of personal income levels in the Basin, there is a strong possibility that growth in these industries will not be as important as in previous periods. If the area is to enjoy growth in a relative sense, it will have to be stimulated from outside the Basin in the form of demand for resources and services available in the area. This will most likely be for mineral and/or recreational purposes.

AGRICULTURE AND RELATED ACTIVITY

Agriculture is an important segment of the study area economy. Although the number of farms and farm operators is declining, agriculture is an expanding industry. It is expanding in terms of total value of production and product diversification, but not in terms of employment. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides, and larger farm machinery. Further increases in efficiencies are expected through 2020. Larger quantities of agricultural products will be required as population of the nation increases. Rising per capita income also leads to additional expenditures for selected food items. As incomes grow, consumers tend to upgrade their diets, and this generally means eating more meat, especially beef.

Beef cattle are the principal source of agricultural income in the Basin. Cattle numbers in the Basin on January 1, 1970, were estimated at 265,000 head. Excluding Yellowstone County, cattle numbered about 204,000 with 188,000 head shipped out of the Basin in 1969 and 56,000 shipped into the three-county area for a net export of 132,000 head. Cattle feeding is growing in importance and may provide the market outlet for silage and feed grain expected to be grown on land going out of sugar beet production. There has been some increase in continuous confinement hog production, but total production is not great. Hog population in 1969 was estimated at 22,000 head. Sheep and lambs numbered about 61,000 in 1970. Chickens numbered about 120,000.

According to the Census of Agriculture, the amount of land in farms and ranches has remained relatively constant. In addition to these privately owned lands, livestock producers obtain grazing leases and permits for public lands, thus increasing the total amount of land used for agricultural production. Several other farm characteristics have changed, table III-10. Out-migration of the population, particularly the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from those specializing in intensively irrigated row crops to those with extensive livestock operations. In 1969, 15 percent of all units were less than 100 acres in size, 47 percent in the 100-999-acre size, 13 percent in the 1,000-1,999-acre size, while 25 percent were in the 2,000-acre or larger category. About 87 percent of the farmland is controlled by farms or ranches larger than 2,000 acres in size.

The per acre value of land and buildings increased two and one-half times between 1954 and 1969. This is partially due to higher land prices and building construction costs, and partially due to other capital

investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased farm size has resulted in an average investment of greater than $150,000 per farm. Large capital requirements are also reflected in farm ownership. The percentage of farmers and ranchers that own only a part of the land they operate rose from 31 percent in 1954 to 40 percent in 1969. Meanwhile, those in the tenant category declined. Apparently some of the farm operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Also, the returns to operating capital are higher than the returns to capital invested in land. Little change can be expected in this trend as farm size, land values, and machinery costs continue to increase.

TABLE III-10--CHARACTERISTICS OF FARMS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Item	Unit	1954	1959	1964	1969
Farms	No.	2,354	1,965	1,826	1,667
Average Farm Size	Ac.	1,795	2,422	2,215	2,625
Ownership Class:					
Full Owner	Pct.	45	41	43	44
Part Owner	Pct.	31	38	40	40
Tenants	Pct.	24	21	17	16
Size Class:					
Under 100 Acres	Pct.	15	12	11	15
100-179 Acres	Pct.	16	14	12	10
180-259 Acres	Pct.	8	7	7	6
260-499 Acres	Pct.	17	17	17	16
500-999 Acres	Pct.	15	17	17	15
Over 1,000 Acres	Pct.	29	33	36	38
Value of Land and Buildings:					
Per Farm	Dol. 1/	36,605	57,985	93,599	156,614
Per Acre	Dol. 1/	23	35	43	60

1/ Current dollars
Source: U. S. Census of Agriculture

SCS PHOTO 11-P1008-2

Modern large feedlots are being developed in the Basin to utilize Montana feed for Montana cattle. (Yellowstone County above; Carbon County below)

SCS PHOTO 11-P869-14

Most of the dry cropland is stripcropped and some of it is protected with single-row windbreaks which also provide wildlife habitat. SCS PHOTO 11-8037-8

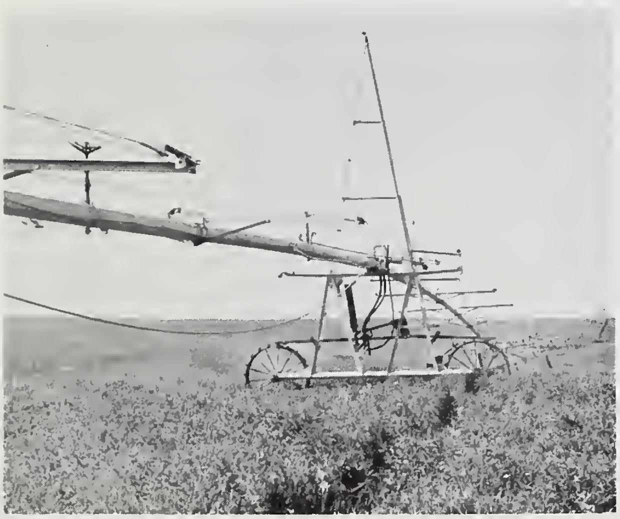
SCS PHOTO

BUREAU OF INDIAN AFFAIRS PHOTO

Dryland farming, by nature, is big enterprise farming.

Corn for silage and grain is increasing in importance as beet acreage declines and cattle feeding increases.
SCS PHOTO 11-P203-13

Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management. (Clarks Fork Valley)
SCS PHOTO 11-P869-2



Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuitable for irrigation under conventional systems. SCS PHOTO 11-P868-15

Red Lodge Mountain (Grizzly Peak) ski area provides about 65,000 skier days per year to people of all ages and skills.
USDA-FOREST SERVICE PHOTO

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugar beet refining, food processing plants, marketing, and transportation industries are heavily dependent upon crops and livestock produced locally. The amount of processing performed varies by type of product and can range from little to none as in the case of feed grains to providing a finished product such as sugar. Farmers and their families are an important source of labor. They can supplement farm income with seasonal, part time, and in some cases with full time jobs. Many are within commuting distance to Billings with a standard metropolitan statistical area population of 87,367. In 1969, 493 or 34 percent of the commercial farm operators (sales of $2,500 plus) from the three-county area also worked at jobs away from their farms. About one-half of these operators held jobs 100 or more days per year.

Land Use and Production

There are approximately 4.1 million acres of agricultural land in the Basin that were inventoried during 1967 to determine use and conservation treatment needs.[1/] Most of this land is used to provide roughage, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Some additional land will be required for interstate highways and for urban and builtup areas near Billings within the planning horizon of this study. The amount of agricultural cropland is expected to remain close to the present acreage. However, recent significant increases in international agricultural trade are resulting in reactivation of diverted acres and conversion of some rangeland to cropland. At present there are no projections available for the future rates of the foreign trade or the degree of land conversion. There also is expected to be some conversion of nonirrigated cropland to irrigation.

Irrigated crops grown in the Basin include hay, sugar beets, corn, small grains, dry beans, pasture, and canning crops. Dryland crops are mainly wheat, barley, and hay. One of the most abrupt changes in the acreage of individual crops occurred recently with the closing of a sugar beet refinery in Hardin. Feed crops, particularly corn, are now grown on the land formerly planted to sugar beets in that area. The production of corn for grain and corn silage is increasing and is used locally by feedlot operators. Oats, dry beans, and legume seed crop acreage is declining. Competing areas have attracted dry bean and seed production away from the Basin.

Federal farm programs also influence land use. Acreage allotments in the past affected the amount of wheat grown in the Basin more so than any other crop.

1/ Conservation Needs Inventory, Montana, 1967

There are about 231,000 acres now irrigated. Nearly 350,000 acres of cropland are without irrigation facilities. Crop-fallow rotations are practiced for the dryland grain crops primarily because of insufficient rainfall. Present and projected land use on state and private lands are shown in table III-11.

TABLE III-11--PRESENT AND PROJECTED LAND USE
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Land Use	Present 1/	1980	2000	2020
	(Acres)			
Irrigated Cropland:	231,419	236,000	250,500	257,000
Wheat	9,850	8,700	8,200	7,500
Barley	12,440	15,000	18,000	20,000
Oats	4,350	3,200	3,000	3,100
Corn, grain	2,900	6,900	13,900	15,000
Silage	13,500	18,000	20,000	22,000
Sugar Beets	10,500	8,400	11,100	13,500
Dry Beans	4,250	3,800	3,300	2,900
Alfalfa Hay	64,270	65,000	65,000	65,000
Other Hay	49,760	48,000	48,000	48,000
Pasture	42,500	43,000	44,000	44,000
Other Crops	6,220	6,000	6,000	6,000
Not Harvested	10,879	10,000	10,000	10,000
Nonirrigated Cropland:	349,522	339,300	347,400	347,000
Wheat	114,200	101,700	106,600	102,600
Barley	39,500	48,000	53,000	57,700
Oats	4,300	3,600	3,800	3,700
Hay	33,500	36,000	34,000	33,000
Fallow	158,022	150,000	150,000	150,000
Range	3,084,493	3,082,900	3,060,300	3,054,200

Source: River Basin Planning Staff
1/ Present cropland use generally represents a 1965-70 weighted average.

The amount of irrigated land is expected to increase from 231,419 acres at present to 236,000 acres in 1980; to 250,500 acres in 2000; and 257,000 acres in 2020. The increase in irrigated land will be used primarily for corn, barley, hay, and pasture. Livestock production will continue to be of major importance and additional roughage and feed grains will be needed.

The amount of nonirrigated cropland is not expected to change appreciably. Land that is suitable for irrigation on public lands may be available for future irrigation development through an exchange agreement; however, this was not considered in the projections.

Productivity per acre has been increasing and can be expected to expand further until 2020. Present and projected crop yields are shown in table III-12. The additional capacity to produce will come about through use of improved crop varieties and management, improved fertilizers and weed control, and application of measures to conserve soil and water resources.

Present and projected production for the major commodities are shown in table III-13. For most crops, present production is a weighted average for the years 1965-70. The amount of grazing on public and Indian Trust lands was obtained through the federal agencies issuing grazing leases and licenses. Currently these lands provide 36 percent of the grazing resource. Current production of livestock commodities was determined by relating inventories and sales for the Basin to state totals and then converted to units of weight.

Projected production from the Basin is based upon the national rate of increase (or decrease) for each commodity and time period. These rates were altered upward or downward for some items based upon a comparison of historical trends between the areas. Upward adjustments were made for corn, oats, and barley. Downward adjustments were made for dry beans and some livestock commodities. Beef, sheep, and wheat approximate the national rate. The national projections are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses of agricultural products.

Most of the agricultural commodities produced in the Basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in other localities or states. The largest segment of cattle production in the Basin consists of cow-calf operations that provide feeders to feedlots. Projections of hay and grazing are based upon the amount of each needed to supply an adequate amount of roughage for cattle and sheep. The amount of roughage from range on public and private lands was added to the amount produced on irrigated land and nonirrigated hay. It is assumed that any additional roughage would come from hay, pasture, and silage. Consequently, most of the increase in irrigated acres is reflected in these roughage crops. One exception is beet tops. It is assumed that all beet tops are fed as silage or grazed.

Currently, the amount of grain fed is in excess of production. The deficit of feed grain is expected to continue through 1980. Sugar beet production is projected to decrease slightly by 1980 and then increase through 2020. Beef production is projected to increase 36 percent by 1980 and 146 percent by 2020. Sheep and milk production will decline by 1980 and then increase.

TABLE III-12--PRESENT AND PROJECTED CROP YIELDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Crop	Unit Per Acre	Present Yield	Projected Yields 1980	2000	2020	Index (Present = 100) 1980	2000	2020
Irrigated Crops:								
Wheat	Bu.	41	47	59	72	115	145	175
Barley	Bu.	53	74	93	106	139	175	200
Oats	Bu.	62	80	99	109	130	160	175
Corn, grain	Bu.	71	93	115	135	130	161	190
Sugar Beets	Ton	16.6	20.1	24.1	29.1	121	145	175
Dry Beans	Cwt.	16.5	20.1	23.9	27.6	122	145	167
Silage	Ton	18.1	23.3	28.4	31.1	129	157	172
Alfalfa Hay	Ton	3.0	3.6	4.3	5.0	120	144	166
Other Hay	Ton	2.4	2.8	3.4	4.0	118	140	165
Pasture	FU1/	2,100	2,520	2,940	3,360	120	140	160
Nonirrigated Crops:								
Wheat	Bu.	27	32	36	42	117	133	155
Barley	Bu.	35	40	47	55	113	135	156
Oats	Bu.	37	42	49	56	114	132	150
Hay	Ton	1.3	1.6	1.8	2.0	120	138	154
Range:	FU1/	100	120	141	160	120	141	160

Source: River Basin Planning Staff

1/ Feed Unit: one feed unit is equivalent to one pound of shelled corn.

TABLE III-13--CURRENT AND PROJECTED PRODUCTION
AND VALUES OF PRODUCTION
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Item	Unit	Price1/ Per Unit	Current	1980	2000	2020
Wheat	Bu.	1.78	3,472,900	3,663,000	4,321,000	4,851,000
Barley	Bu.	.74	2,018,500	3,030,000	4,165,000	5,294,000
Oats	Bu.	.55	419,500	407,000	483,000	545,000
Corn, Grain	Bu.	1.25	205,900	641,000	1,598,000	2,025,000
Sugarbeets	Ton	12.17	174,300	169,000	268,000	393,000
Dry Beans	Cwt.	6.00	67,700	76,000	79,000	80,000
Silage	Ton	8.00	244,400	419,000	568,000	684,000
All Hay	Ton	22.00	344,800	426,000	504,000	583,000
Pasture	FU2/3/	.015	86,100	108,360	129,360	147,840
Range	FU2/3/	.015	196,493	235,740	275,000	314,300
Range5/	FU2/3/	.015	160,615	161,311	178,918	178,918
Beef	Lb2/4/	.2288	86,310	117,400	158,100	212,400
Pork	Lb2/4/	.1505	8,184	9,820	12,000	15,000
Sheep	Lb2/4/	.1323	3,147	2,830	3,210	3,780
Wool	Lb2/	.48	598	538	610	718
Milk	Lb2/	.039	30,000	27,200	30,600	35,800
Eggs	Doz.2/	.35	1,508	1,625	2,050	2,567
Poultry	Lb2/4/	.05	300	345	435	540
Aggregate Value of Production	Dol.2/		50,276	63,224	81,783	102,581
Value of Feed Utilized	Dol.2/		18,171	23,573	29,727	34,663
Gross Value of Production	Dol.2/		32,105	39,651	52,056	67,918

Source: River Basin Planning Staff

1/ Current Normalized Price, Interim Price Standards for Planning and Evaluating Water and Land Resources, Water Resources Council, April 1966.

2/ Units in thousands.

3/ A feed unit has the equivalent feeding value as one pound of shelled corn. One Animal Unit Month (AUM) = 450 feed units.

4/ Live Weight Basis.

5/ Grazing obtained through leases and licenses administered by Federal Agencies.

There are numerous considerations inherent in making projections for any area. The foregoing agricultural production projections are based upon national trends and adjusted for local conditions. Any changes in national trends, such as rates in population growth, exports, consumer tastes, and per capita income will be reflected in the nation's level of agricultural output. This, in turn, will likely affect the projections of agricultural production for the study area. Alternative projections which reflect some of the above items are being prepared, but are not available for use in this report. Depending on changes in international trade, increases in agricultural production may or may not result in displacing production in some other area or areas. Large production increases may affect market prices to the extent that total returns to agriculture are lower.

There is the possibility that technology will not be available to increase crop yields to the extent shown in the projections. If yields on cropland are overestimated by 10 percent, an additional 22,000 acres of irrigated and 20,000 of nonirrigated cropland would be needed by 1980 to produce the same amount of output. By the year 2020, an additional 24,000 acres of irrigated and 20,000 acres of nonirrigated cropland would be required. If present estimates of future crop yields are underestimated, then less than the projected acres of new cropland will be needed to provide the same level of output.

The importance of public land as a source of grazing was indicated earlier. It is expected that these lands will remain available for lease to livestock producers. However, if this resource were not available to livestock grazing, other sources of pasture and range would be needed. It would require 8,200 acres of irrigated pasture to replace the amount of grazing that will be utilized on public lands by 1980. By 2020, 6,400 acres of irrigated pasture would replace grazing on public land.

FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY

Forested land makes up over 616,000 acres in the Montana portion of the Basin. Most of the timber resources in the area are located in the western third of the Basin and in the Pryor and Bighorn Mountains. Approximately one-half of the forest land is federally owned. Of the 305,019 acres of national forest timber land, 178,329 acres are classified as commercial. An additional 24,603 acres of commercial quality timber land are located within the Beartooth Primitive Area on the Custer and Gallatin National Forests, but no timber harvest is permitted on these areas. Private, State, and Indian Trust lands account for 91,338 acres, or 34 percent, of the commercial timber land. Acres of commercial and noncommercial forest land by ownership class are shown in tables II-5 and II-6.

Tree species most commonly harvested are Douglas-fir and lodgepole pine. Some Engelmann spruce and alpine fir have been harvested from sites at higher elevations.

Most of the publicly owned forested land in the Basin is located in mountainous terrain. Limitations of accessibility, small tree size, unstable soils, steep and rocky slopes, severe weather, short operating season, and long hauling distance to markets limit the operability of these commercial timber lands. In addition, public reaction against harvest practices as well as increasing recreation pressures have kept timber harvest from public forested lands from exceeding one million board feet in recent years. This situation is expected to continue and may even cause a further decrease in annual harvest.

Most timber harvested in the Basin comes from Indian Trust lands in the Crow Indian Reservation. Due to difficulty in marketing smaller volumes, annual sales are only about five million board feet. This level is anticipated to continue for about five years. However, timber sales from these lands after that time will be very small while the younger stands are allowed to reach maturity. This situation is expected to continue for 20-30 years.

Other private forested lands in the valleys and the foothills of the Basin are found in stringers along watercourses, in small patches, or in inaccessible canyons. The poor quality and small size of much of this timber and its scattered location make much of the resource economically inoperable.

The low volumes of timber available from public and private lands and the widely varying volumes harvestable over time from Indian Trust lands contribute to the difficulty of promoting intrabasin forest industry growth. Two other factors are a lack of available skilled woods workers and the purchase of most timber harvested by processing mills located near, but outside, the Basin.

Of the approximately six million board feet of timber harvested in the Basin, only one-fourth of it is processed by four mills located in Carbon and Stillwater Counties. The primary product is rough (green or dry) lumber which is sold locally. The volume of timber processed in the Basin is not expected to rise due to the anticipated decrease in availability of harvestable timber in five years. In fact, the volume processed may even decrease. In spite of the existence of enough timber volume to support the present mills and perhaps an additional small operation such as a stud mill, the above constraints would preclude economic operation of new facilities.

Consequently, the role of the forest industry in the Basin economy will continue to be slight. The timber produced will merely contribute to larger scale operations located outside the Montana portion of the Basin which can draw on much larger and more productive timber growing areas. This peripheral processing activity is meeting Basin demands for products, although higher quality timber products are being shipped in from outside the area.

Resources from forested lands other than timber have become increasingly significant. The water yielded from these lands has relatively high quality except in mine acid drainage areas, and forest land should be managed so that high quality may be maintained.

OUTDOOR RECREATION

Outdoor recreation particularly on forested lands provides considerable economic benefit to the area. A number of nationally recognized recreational resources exist in the Basin or cause people to travel through it. These are Bighorn Canyon National Recreation Area established around Bighorn Lake, Custer Battlefield National Monument, Beartooth Primitive Area, Pryor Mountain Wild Horse Range (all within the area), and Yellowstone National Park nearby. These attractions, along with others of the area, lure about three times as many people from Montana as from other states. The heaviest use naturally occurs during the summer months of favorable weather, but increasing activity is occurring during the winter in the form of snowmobiling and skiing. For example, 67,000 skiers visited the ski area near Red Lodge in 1971. Preferred activities of people recreating in the area are: resting and relaxing, camping, fishing, pleasure walking, hiking, and driving for pleasure.

The popularity of the Basin area and its proximity to Montana's largest city have contributed to extensive development of recreational residences along the Stillwater River and the upper reaches of the Beartooth range drainages. These types of residences have also begun to appear near the Pryor Mountains. The lower Clarks Fork valley has attracted many retirees due to its location and favorable climate. This characteristic is supported by the fact that 45 percent of the recreationists are over 44 years old and 29 percent are unemployed.

The economic impact of these developments as well as the transient recreational activity are certainly greater than that derived from any other forest land product. Continued efforts to meet the rising recreational demands will likely reinforce this economic relationship. It is certain that both private facilities such as motels, cafes, dude ranches and outfitting services, and public facilities, especially local and state, will increase in the future.

RELATIONSHIP OF ECONOMIC DEVELOPMENT TO WATER RESOURCE DEVELOPMENT

The employment, income, and stability of the economy are directly tied to water resource development. Most of the irrigation development has been accomplished by private ditch companies and individual ranchers. Project development was limited to the Indian reservation and the Huntley irrigation project. Production from irrigated agriculture provides many more jobs than the same area would provide under dryland cropping or ranching. In general, irrigated production is more dependable than that from range or dryland. This stability and higher production provides a

base for agriculturally oriented industry and other social developments such as roads, schools, hospitals, and churches. In turn, an area with established social development attracts other investment in light manufacturing and service industries. That has been the pattern of development in the Basin.

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

This chapter presents the problems related to water and land resources that were identified by the river basin planning staff and cooperating state and federal agencies during this study.

EROSION DAMAGE

The severity of erosion damage varies widely in the Basin. Some of the mountain areas and better cropland areas show no recent evidence of any significant erosion. On the other hand, many badland areas were formed entirely by erosion. Considering this wide range of erosion damage, lands are classed into the three erosion hazard categories of "slight," "moderate," and "severe," as determined by their erodibility. These categories are indicated by topography, surface geology, and soil texture, structure, and chemistry. Erosion hazard classes are independent of the ground cover, land use, stream channel characteristics, climate, and runoff. However, vegetative cover, climate, and runoff characteristics of an area can either substantially subdue or exaggerate the extent of erosion.

Slight erosion hazard generally exists on gentle upland slopes (less than 5 percent) with deep, coarse-grained, permeable soils; strongly sloping uplands with massive resistant bedrock surfaces and very shallow rocky soils; and extensive alluvial flood plains composed of mature soils with definite profile development, or aggregated soils with clay and organic binders. As the category suggests, these lands present very few erosion problems.

Moderate erosion hazard areas generally exist on moderate upland slopes (less than 20 percent) with shallow soils containing some rock fragments and alluvial fans or immature flood plains composed of medium-textured mixed soils with some binders.

Severe erosion hazard areas generally exist on steep upland slopes (in excess of 20 percent) with very little flood plain development, composed of deep, single-grained, silty and sandy soil or marine shales and siltstones that are easily dispersed and have high shrink-swell potentials or high sodium concentrations.

The Conservation Needs Inventory conducted in 1966 and published in 1970 shows that 43 percent of the cropland in the Basin counties have moderate erosion hazards and another 16 percent have severe erosion hazards. Nineteen percent of the inventoried pasture, range, private forest, and other lands have moderate erosion hazards and an additional 55 percent have severe erosion hazards. In other words, most of the lands with the least erosion hazards have already moved into crop production while lands with more serious erosion hazards are used for grazing or other extensive purposes. Much of the rangeland has such high erosion hazard that careful range management is needed to prevent land destruction and sediment production.

Most land treatment problems on these erosion hazard soils are concerned with soil cover to minimize water erosion. Wind erosion is a problem on some dry cropland.

In addition to man-caused accelerated erosion, there is considerable geologic erosion, for which there is no economically feasible solution, on both private and public lands. Overgrazing and misuse of steep rangeland can accelerate rilling and gully erosion. Some badland areas in the U. S. may well have started from overgrazing and trampling by migrating buffalo. Heavy rains following cover destruction start accelerated erosion--particularly in arid and semiarid areas similar to parts of the Basin. Other causes of accelerated erosion include indiscriminate use of wheeled vehicles, poorly designed roads and trails, farming too close to streambanks, channel straightening, poor reclamation of petroleum and mineral exploration areas and timber harvest areas, and poor irrigation and tillage practices. There are local areas of severe streambank and channel erosion in natural drainages being used to transport irrigation and waste water. Examples are Sand Coulee, Silvertip, Dry, Elbow, and Rushwater Creeks. Failure to recognize fragile vegetation and erodible soils has resulted in widespread cases of accelerated erosion.1/

Streambank erosion is moderate to severe on 71 miles of the Clarks Fork and its tributaries and 90 miles of the Bighorn and its tributaries. There are 40 miles of bank erosion along Pryor Creek and other direct tributary drainages into the Yellowstone River. Bank stabilization may be needed in some cases.

SEDIMENT DAMAGE

Sediment is a by-product of erosion. Where one can control the latter, he can control the former. In some isolated cases, cropland along streams and on alluvial fans receives deposits of infertile sediments. These deposits generally produce a short-term reduction in crop yields. The soils in these alluvial areas originated from just such deposits. Over time, the new deposits are mixed with the soil and organic matter and production is restored or, in some cases, enhanced.

In some areas, irrigation canals trap sediment from overland flooding to such an extent that their transport capacity is reduced. The cost of periodic cleaning and repair of these canals increases crop production costs.2/ Sediments originating from marine shales often carry undesirable salts into streams, stock water reservoirs, and onto cropland. Sediments

---

1/ For information on localized erosion and sediment problems, see "A Study of Erosion and Sedimentation, Montana Portion, Clarks Fork of the Yellowstone River Basin," January 1973, prepared for Montana Legislative Assembly.
2/ About 20 percent of canals and laterals have to be cleaned each year.

Sediment accumulation of 36 years has reduced the storage capacity and attractiveness of Cooney Reservoir in Carbon County. SCS PHOTO 11-P830-7

Overuse of stream bottom has destroyed browse and game habitat.
USDA - FOREST SERVICE PHOTO

Streambank erosion of sandy soils along Elbow Creek. SCS PHOTO 11-P870-7

Permeable log jetties constructed on the Bighorn River in an attempt to control bank erosion. SCS PHOTO 11-4954-3

PLATE 16

SCS PHOTO 11-P966-4

In order for open drainage ditches to function properly, they must receive annual maintenance to remove debris and sloughed-in banks and to be kept free from excessive vegetative growth. Two Leggins Irrigation Unit.

SCS PHOTO 11-P966-5

PLATE 17

shorten the life of reservoirs. See table IV-1. Trout reproduction is severely limited by sediment in the Clarks Fork and some of its tributaries.

TABLE IV-1--SEDIMENT YIELDS ON SELECTED RESERVOIRS BASED ON SUSPENDED LOAD AND/OR RESERVOIR SURVEYS WIND-BIGHORN-CLARKS FORK RIVER BASIN

Reservoir Name & Subbasin	Drainage Area Above Reservoir	Sediment Yield Average Annual	
		Total Acre-Feet	Acre-Feet per Square Mile
	(square miles)		
Boysen Reservoir	7,767	1,398	0.18
Bighorn Reservoir			
Bighorn River	8,598	3,525	0.41
Shoshone River	1,492	746	0.50
Buffalo Bill Reservoir	2,023	708	0.35

Source: River Basin Planning Staff

Sediment Yields

Sediment yields depend on a combination of the erodibility of the soils and parent materials, vegetative cover is affected by climate and soil conditions, steepness of slope, and the pattern of precipitation. For example, 10 percent of the Basin is underlain by Precambrian igneous and metamorphic rock. This area is located at high elevation and has high rainfall and good vegetative ground cover. The area produces 37 percent of the Basin water runoff, but only 4 percent of the Basin sediment yield. In contrast, 13 percent of the area is underlain with tertiary sedimentary rock. This latter area produces only 9 percent of the runoff, but produces 22 percent of the sediment yield. The highest sediment yield is found in the arid breaks of exposed marine shales where salt concentrations and low rainfall inhibit vegetative growth. Procedures used in preparing the sediment yield map do not involve the delineation of areas based on particular-sized watersheds. Each delineation provides a range of rates that in general encompass sediment yield possibilities. The mapping procedure used leads to a general portrayal of conditions and not for specific projects. See table IV-2 and map IV-1. In addition, cloudbursts are the typical summer rainfall pattern.

Sediment yields in the lower Wind-Bighorn-Clarks Fork River Basin are estimated to range from less than .05 to a maximum of 1.0 acre-feet per square mile per year (map IV-1 and table IV-2).

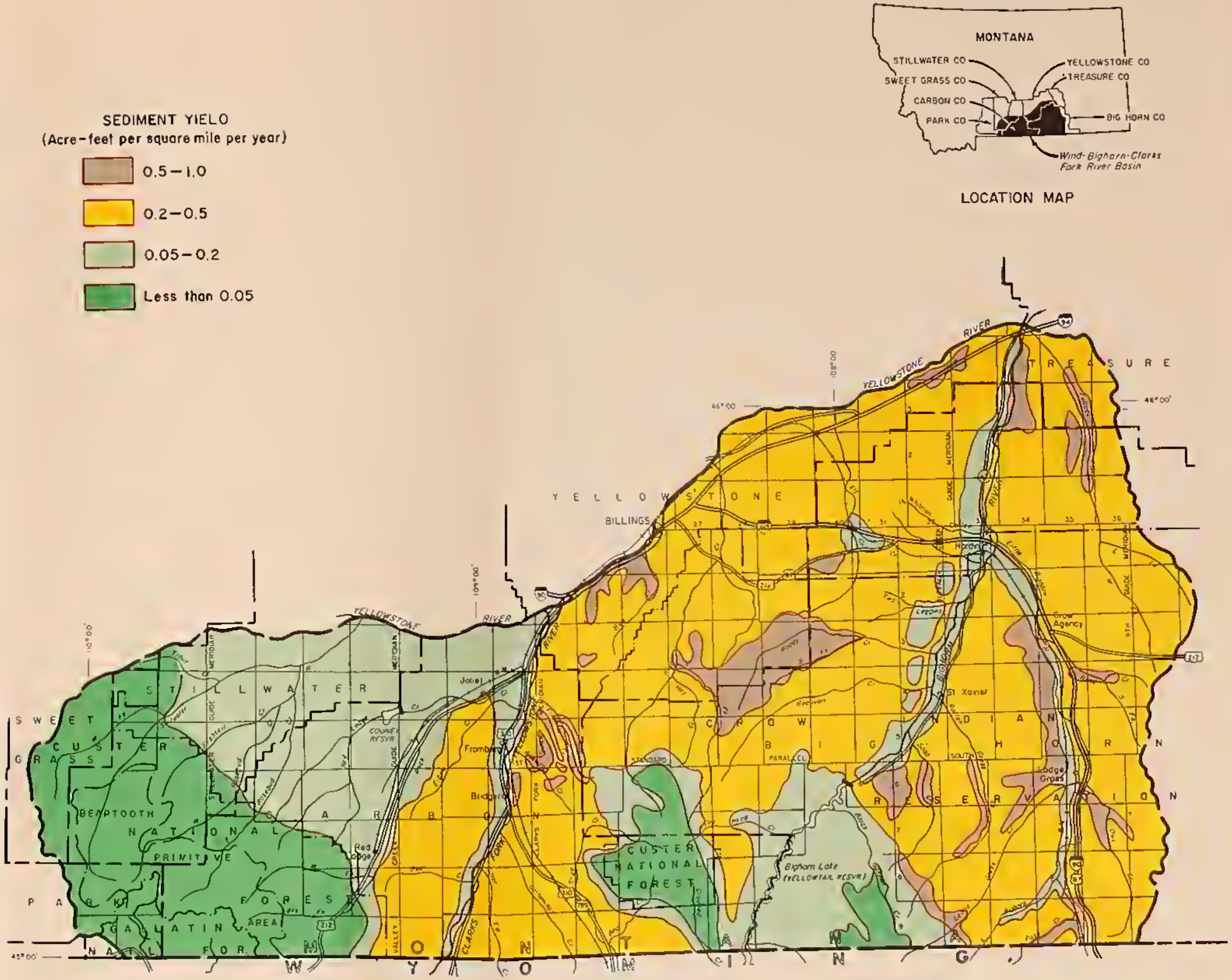
TABLE IV-2--RELATIONSHIP OF GEOLOGIC FORMATIONS
TO WATER AND SEDIMENT YIELDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Type of Rock	Percentage of Basin Area	Estimated Yields: Water Percentage of Basin Yield	Estimated Yields: Sediment Percentage of Basin Yield
	Percent		
Precambrian Igneous and Metamorphic	10	37	4
Paleozoic and Mesozoic Sedimentary	64	42	49
Cretaceous-Tertiary Pyroclastics & Volcanic Extrusives	1	2	1
Tertiary Sedimentary	13	9	22
Quaternary Alluvium and Terraces	12	10	24
TOTALS	100	100	100

Source: River Basin Planning Staff

The highest sediment yield areas include the drainages tributary to the Bighorn and Little Bighorn Rivers and basins tributary to the upper part of the Clarks Fork River in Montana. These areas, which are composed largely of moderately steep, generally rough, broken topography underlain by soft, erosive shale and sandstone strata, are predominantly affected by geologic erosion. However, the area does include some cultivated lands with fine-grained erodible soils.

Mountainous areas composed of the Beartooth Range and the Bighorn and Pryor Mountains have sediment yield rates estimated to be less than .05 acre-feet per square mile per year. These areas are characterized chiefly by hard, erosion-resistant crystalline and sedimentary rocks, relatively free-draining stable soils, and good vegetative cover locally. However, localized problem areas occur in the form of eroding trails caused by over-use by livestock and four-wheel drive vehicles on high mountain meadows and steep slopes. These tracks often become small gullies contributing sediment to tributary streams. Surface disturbance



MAP IV-1

SEDIMENT YIELD MAP

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914K

caused by bulldozers during exploration for minerals has caused considerable damage to mountainous areas and contributes significantly to localized sediment problems. Overgrazing has also bared slopes in some forested areas which continue to contribute sediment to stream courses.

Associated with the steep, mountainous terrain are rolling uplands and high plains characterized predominantly by soft sedimentary strata and poor-to-fair vegetative cover with an estimated yield rate of .05-.2 acre-feet per square mile per year. These areas include some moderately steep mountainous lands underlain by fairly hard, resistant sedimentary rocks flanking the Pryor and Bighorn Mountains.

Broadly terraced river valleys and gentle-to-moderately rolling interstream uplands, characteristic of the Great Plains which comprise much of the Basin area, have sediment yield rates of .2-.5 acre-feet per square mile per year. The chief factors in sediment production in these areas include soft, erodible shale, siltstone, and sandstone strata which underlie a large part of the area, silty to silty sandy dispersed soils, and high intensity cloudburst-type storm activity. Long slopes characteristic of the uplands are particularly susceptible to accelerated erosion where the grass cover is sparse.

Previous investigations made in connection with the Missouri River Basin Framework Study (1968) indicate that variations in sediment yields are generally fairly closely associated with the surface geology. An inverse relationship generally exists between rainfall and soil erodibility with the more erosive, more easily dispersed soils occurring in the lower rainfall areas.

The sediment yield map prepared for this report represents to a limited extent a refinement of the sediment yield map prepared previously by the Task Force on Sedimentation (1968) for the Missouri River Basin Framework Study. This refinement is based to a large degree on known areas of geologic and cropland erosion, combined with a fairly detailed knowledge of local watershed characteristics as related to sediment production. The sediment yield map prepared for the Missouri River Basin Framework Study (1968) was based primarily on suspended sediment discharge records and reservoir sediment data.

FLOODWATER DAMAGES

In general, historical data from newspaper morgues do not show sufficient economic damage on most of the small watersheds in the Basin to justify single-purpose flood prevention projects. Flood damages are generally confined to sparsely inhabited cropland areas. Some roads, bridges, farm outbuildings, machinery, and livestock have been lost and some crops have been destroyed, but not with a high degree of frequency.

Damages to fences and crops are seldom reported in newspapers. Table IV-3 shows a brief resume of newspaper records of flood damages by watershed area. Table IV-4 shows estimated average annual damages by subbasins. Table IV-5 shows projected damages by subbasins. Residential flood damages have occurred in Red Lodge, Lodge Grass, and along Blue Creek.

TABLE IV-3--YEARS OF MAJOR FLOODS ON SELECTED WATERSHEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

	Years of Record										
Watershed Name	'60	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70
14b-2 Fishtail to Butcher Creek				M				S	S		
14-27 Blue-Duck Creek				S	S	S				S	
14d-1 and 2 Pryor Creek				S	S	S					
14c-7 Clarks Fork-Ruby Creek					S						
14c-9 Red Lodge-Rock Creek			S	M				S	S		
14e-37a Two Leggins				S				S			
14e7-3 Lodge Grass Creek						S				S	

Source: River Basin Planning Staff and Newspaper Morgues
S = Serious Flooding
M = Moderate Flooding

The water wells for the town of Joliet were flooded in 1964; as a partial result, the residents of Joliet passed a bond issue and drilled new wells outside the flooded area. The town of Fishtail often receives winter flooding caused by ice building up in the West Rosebud Creek channel during fluctuating operation of the Mystic Lake power plant by Montana Power Company.

TABLE IV-4--ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE ON SELECTED DRAINAGE

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Major Drainage	Flood Plain Area	Current Average Annual Damage 1/				
		Crop and Pasture	Other Rural	Urban	Indirect	Total
	(Acres)	- - - - - - - - - - - - - -	Dollars	- - - - - - - - - - - - - -		
Stillwater River Subbasin	3,400	2,400	6,100	5,000	NA	13,500
Clarks Fork Subbasin	15,200	20,400	33,500	16,000	NA	69,900
Bighorn Subbasin (including Little Bighorn)	32,500	30,100	42,900	58,400	NA	131,400
Yellowstone Minor Tribs.	29,800	53,600	80,300	104,600	NA	238,500
TOTAL	80,900	106,500	162,800	184,000	NA	453,300

Source: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff

1/ Price base: Urban and Other Rural = 1960; Crop and Pasture = 1964.

TABLE IV-5--SUMMARY OF CURRENT AND PROJECTED FLOOD DAMAGES
in the
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Subbasin	Area Subject to Flooding	Average Annual Flood Damages 1/ Under Current Economic Development	Under Projected Economic Development 2/ 1980	2000	2020
	(1000s Acres)	(1000s Dollars)			
Stillwater:					
Main Stem	2.0	8.5	10.7	18.2	31.2
Tributaries	1.4	5.0	6.7	11.9	21.4
Clarks Fork:					
Main Stem	10.5	30.2	39.0	66.9	116.7
Tributaries	4.7	39.7	49.7	82.3	139.3
Bighorn:					
Main Stem	15.1	59.6	74.9	130.4	227.9
Tributaries (including Little Bighorn)	17.4	71.8	90.7	158.4	277.7
Yellowstone Minor Tributaries:					
Main Stem	20.0	111.1	139.4	232.6	394.9
Tributaries	9.8	127.4	166.6	289.8	511.7
Montana TOTALS	80.9	453.3	577.7	990.5	1,720.8

Source: Missouri River Basin Comprehensive Framework Study and River Basin Planning Staff.

1/ Price base: Urban and Other Rural = 1960; Crop and Pasture = 1964.
2/ Projection coefficients from Missouri River Basin Comprehensive Framework Study.

IMPAIRED DRAINAGE

About 50,000 acres in Montana's part of the Basin have impaired drainage problems. There are wet areas along the flood plains of the Clarks Fork, Bighorn, Little Bighorn, and Yellowstone Rivers and some of their tributaries. Most of the wet areas in the Basin exist because of impaired drainage and, in some areas, artesian ground water. Impaired drainage is related to restricted movement of water away from the wet area to the local drainage system. A natural high water table, over-application of irrigation water, insufficient outlets for irrigation waste water, and seepage from irrigated upper benches and canals can aggravate the situation. Artesian pressure in the underlying alluvium or bedrock aquifers can raise the water table abnormally high. Depth of water table is governed by configuration of the impermeable floor under water-bearing material, rate of recharge, transmissibility of the aquifer, and topography.

Drainage studies have been made on some of these wet areas, but financial limitations and lack of local initiative have delayed remedial construction. Huntley project in the Yellowstone River valley has about 11,500 acres where the water table is less than 6.0 feet below the surface or where a salinity problem exists. Potential drainage projects in the Clarks Fork valley total about 6,500 acres. In the Big Horn River valley north of Yellowtail Dam, there are over 45,000 acres under irrigation. Waterlogging has occurred on about 24,000 of these acres. There are approximately 5,900 acres in the Little Big Horn valley that have a high water table. Many of these are found in low areas associated with old meanders of the river.

Floodwater in the valleys of Tullock, Beauvais, and Pryor Creeks causes local waterlogging of soils in isolated areas of low elevations. The effect is particularly detrimental when flooding occurs during the growing season.

Waterlogging and salinity are often caused by capillarity in the problem areas. Texture and hydrological properties of the soil, temperature, and salinity govern the height of capillary rise. Waterlogging usually does not occur when the water table is over six feet deep in clay soils; over four feet with medium-textured soil; or over three feet in sandy soil. Problems will normally appear whenever the water is within four to five feet of the surface. The resulting elevated water tables, soil drowning, and periodic surface ponding decrease crop production, increase operating costs, and increase the mosquito and vector problems of these areas. See Impaired Drainage Map IV-2.

WATER SUPPLIES--IRRIGATION DEMANDS--SHORTAGES

Lands irrigated by diversion or pump-lift out of the Yellowstone and Bighorn Rivers have a full supply of late season water because flows in these rivers hold up well through the summer. Lands that are irrigated out of minor tributaries are often short of water. The Stillwater

drainage generally has more water available than there is land to irrigate. There are about 97,900 acres currently irrigated in watersheds in which there are deficits of late season water 50 years out of 100. Temporal surplus spring runoff is sufficient within the study area to provide a full supply to all of those acres if it were stored for later use. See figure IV-1.

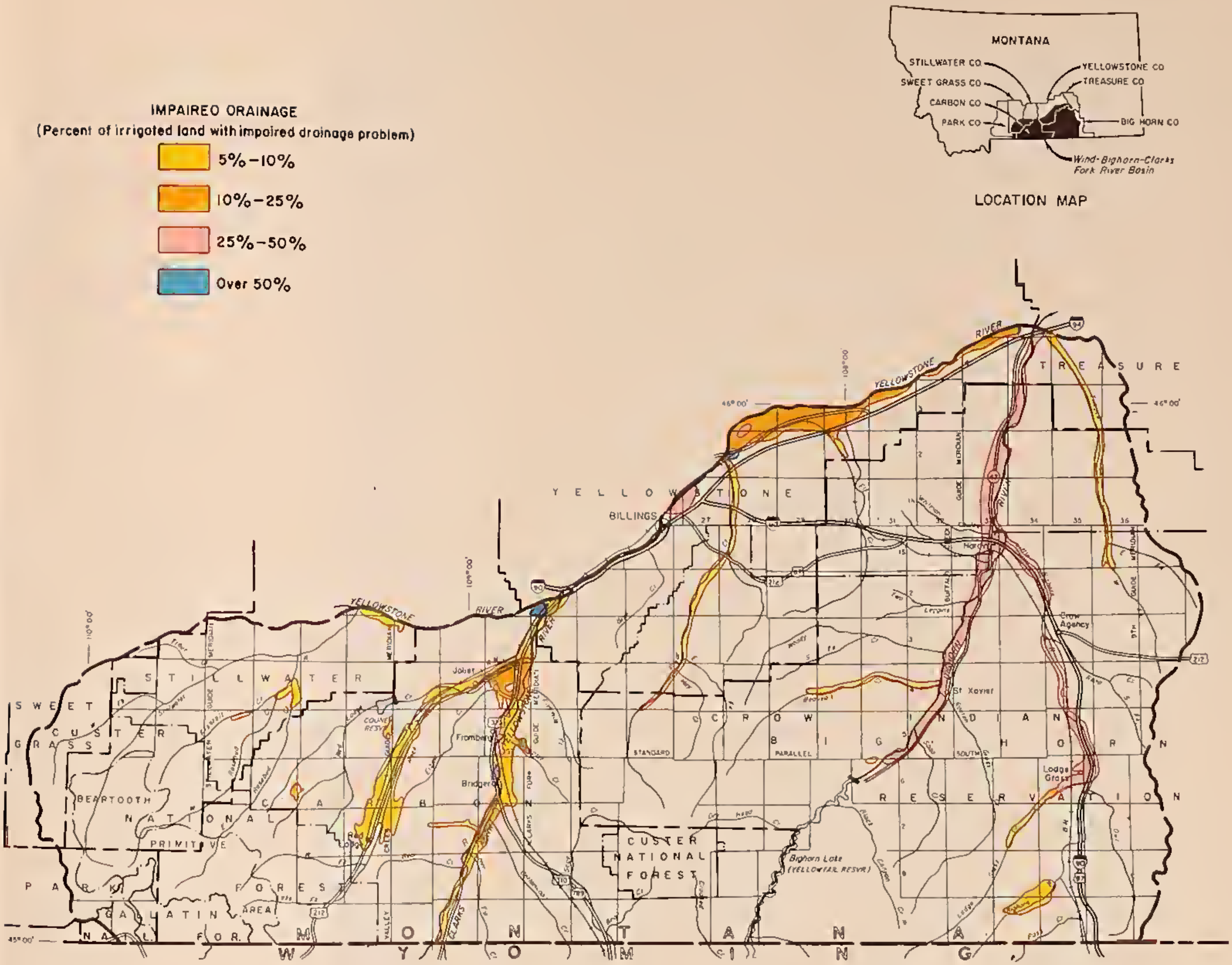
Aside from actual late season shortages of water supply, most of the irrigation development is plagued with low efficiencies in water distribution and on-farm irrigation use. Some recent canal measurements in Carbon County revealed as much as 60 percent loss of water between the point of diversion and the headgate of the first farm on the canal. Much of this water finds its way back to the stream through ground water, but considerable quantities are lost to deeper percolation, phreatophytes1/, and surface evaporation. As a result of haphazard development and the existing pattern of water rights, there are many duplicating ditches with some ditches crossing over or under one another. Maintenance costs and overall water losses are high. See table IV-6.

Water supply shortages on presently irrigated lands have been estimated using present irrigation efficiencies and are shown by hydrologic subareas and subbasins in table IV-6. The present water diversions shown in columns 5 and 8 have been reduced in many subareas so the amount shown will not exceed the computed diversion requirements shown in column 4. This was necessary so that the correct supply needed for storage or transfer could be shown in columns 6, 7, 9, and 10. Many irrigators are diverting more water than is necessary for a full irrigation supply. Data are shown for both the 50 and 80 percent chance year. Surface water resources data of native water supply, flows from upstream sources, depletion by phreatophytes, reservoir evaporation, irrigation depletions, and water supply remaining at the outlet of the subarea for the 50 and 80 percent chance year are shown in table II-8. Data for table IV-6 were developed using the data assembled for table II-8.

The actual water available for storage or remaining needs for a given watershed will depend on downstream water rights and demands and will vary from the values shown in table IV-6. These latter values are based on annual water budget studies and indicate where annual rather than temporal water shortages and surpluses exist.

Flows in smaller streams are often too low for good trout production in late summer and are further aggravated by irrigation diversion.

1/ Phreatophyte plant classification describes a distinct group of plants which survives by drawing water directly from the zone of saturation.



MAP IV-2

IMPAIRED DRAINAGE

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914L

USDA SCS-PORTLAND, OREG. 1973

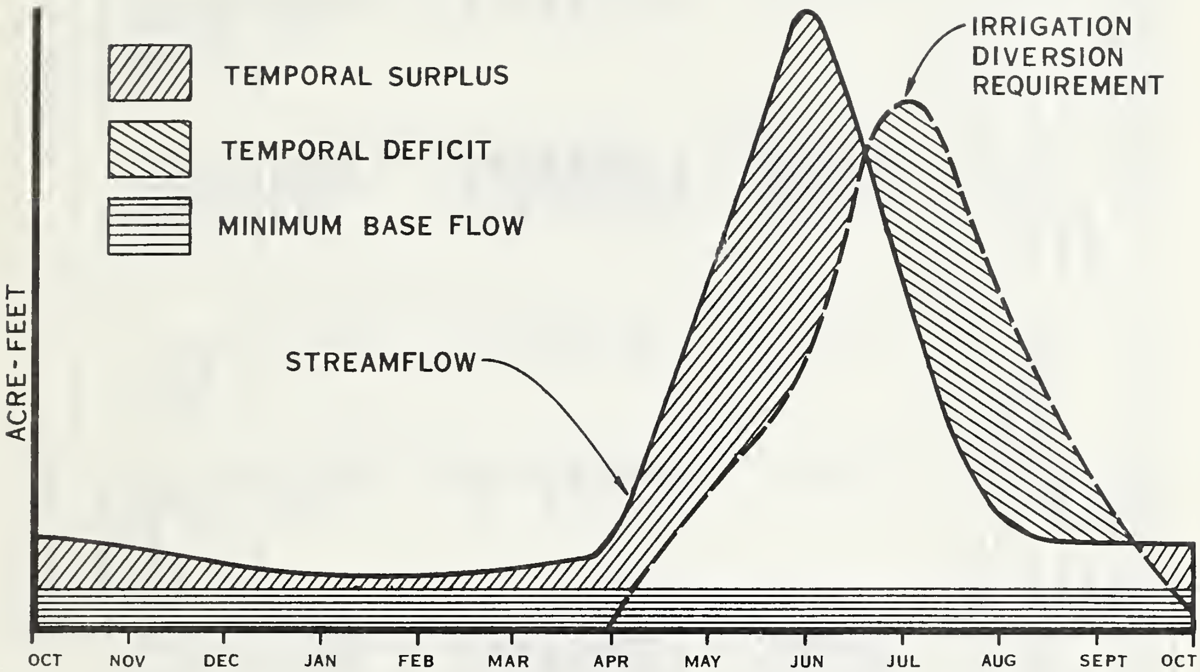


FIGURE IV-1 -- TYPICAL STREAMFLOW AND IRRIGATION DIVERSION REQUIREMENT CURVES

Livestock water shortage is a problem on about 1,450 dry range sites involving about 925,000 acres. Some areas have poor materials for dams or too pervious basins for stock water reservoirs.

Potable water for human consumption is plentiful except for some areas around Fromberg and on the heavier soils and shale areas along the Bighorn valley from Bighorn Lake (Yellowtail Reservoir) to Hardin.

PHREATOPHYTES

Phreatophytes in the Basin consist of cottonwoods, willows, water birch, alder, cattails, rushes, and sedges. Most of these serve some beneficial use as habitat for wildlife even though they are heavy users of water. It is estimated that 224,540 acre-feet of water are used each year by 43,199 acres of phreatophytes. This volume of water is

TABLE IV-6--WATER SUPPLY SHORTAGES ON PRESENTLY IRRIGATED LANDS WITH PRESENT EFFICIENCIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Numbers	Hydrologic Subareas	Present Area of Irrigated Land (Acres)	Irrigation Diversion Requirement 1/ (Acre-Feet)	50 PERCENT CHANCE: Present Water Diversions 2/	50 PERCENT CHANCE: Need For Storage or Transferred Water 3/	50 PERCENT CHANCE: Transfer Needs	80 PERCENT CHANCE: Present Water Diversions 2/	80 PERCENT CHANCE: Need For Storage or Transferred Water 3/	80 PERCENT CHANCE: Transfer Needs
				Acre-Feet			Acre-Feet		
	Stillwater Subbasin								
14b-1	Upper Stillwater River	768	5,000	5,000	0	0	5,000	0	0
14b-2	Fishtail to Butcher Cr.	18,843	117,750	117,750	0	0	117,750	0	0
14b-3	Lower Stillwater River	5,490	27,440	27,440	0	0	27,440	0	0
14b-4	Shane-Beaver Creek	4,151	24,920	24,920	0	0	24,920	0	0
	Subbasin Total	29,252	175,110	175,110	0	0	175,110	0	0
	Yellowstone Minor Drainages								
14-22	Cow-Bellion Creek	1,610	12,050	12,050	0	0	12,050	0	0
14-27	Blue-Duck Creek	3,124	23,450	23,450	0	0	23,450	0	0
14-31	Arrow Creek	27,990	170,080	170,080	0	0	170,080	0	0
14-32	Fly Creek	1,250	7,620	7,620	0	0	7,620	0	0
14-36	Lost Boy Creek	1,058	7,480	7,390	90	0	7,390	90	0
14-37	Custer Drainage	2,200	15,960	15,300	660	0	15,300	660	0
14d-1	Upper Pryor Creek	1,371	10,300	10,300	0	0	10,300	0	0
14d-2	Lower Pryor Creek	1,348	6,730	6,730	0	0	6,730	0	0
	Subbasin Total	39,951	253,670	252,920	750	0	252,920	750	0
	Clarks Fork Subbasin								
14c-3	Clarks Fork-Zimmer Creek	0	0	0	0	0	0	0	0
14c-4	Pat O'Hara Creek	112	950	900	50	0	900	50	0
14c-4a	Big Sand Coulee	968	8,100	7,750	350	0	7,750	350	0
14c-6	N.F. Cherry-Silvertip Creek	10,633	69,320	68,040	1,280	0	68,040	1,280	0
14c-7	Clarks Fork-Ruby Creek	11,385	74,240	72,880	1,360	0	72,880	1,360	0
14c-8	Upper Rock Creek	40	400	400	0	0	400	0	0
14c-9	Red Lodge-Rock Creek	39,308	265,310	265,310	0	0	213,200	52,110	52,110
14c-10	Elbow-Lower Rock Creek	19,100	119,730	44,340	75,390	75,390	13,860	105,870	105,870
14c-11	Lower Clarks Fork-E. Side	7,082	44,380	43,580	800	0	43,580	800	0
	Subbasin Total	88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980

See footnotes on following page.

TABLE IV-6--WATER SUPPLY SHORTAGES ON PRESENTLY IRRIGATED LANDS WITH PRESENT EFFICIENCIES (Continued)

Watershed Numbers	Hydrologic Subareas	Present Area of Irrigated Land (Acres)	Irrigation Diversion Requirement 1/ (Acre-Feet)	50 PERCENT CHANCE: Present Water Diversions 2/	50 PERCENT CHANCE: Need For Storage or Transferred Water 3/	50 PERCENT CHANCE: Transfer Needs	80 PERCENT CHANCE: Present Water Diversions 2/	80 PERCENT CHANCE: Need For Storage or Transferred Water 3/	80 PERCENT CHANCE: Transfer Needs
				- - - Acre-Feet - - -			- - - Acre-Feet - - -		
Bighorn Subbasin									
14e6-8	Sage Creek	1,449	9,160	9,160	0	0	9,160	0	0
14e-27	Crooked Creek	332	2,080	2,080	0	0	2,080	0	0
14e-28	Porcupine Creek	0	0	0	0	0	0	0	0
14e-30	Dryhead Creek to Wyoming	134	840	840	0	0	840	0	0
14e-32	Soap Creek	4,507	29,400	28,840	560	0	24,230	5,170	5,170
14e-33	Beauvais Creek	1,122	9,200	9,000	200	0	9,000	200	0
14e-34	Rotten Grass Creek	17,088	80,540	78,110	2,430	0	78,110	2,430	0
14e-35	Two Leggins-Woody Creek	15	100	100	0	0	100	0	0
14e-37	West Side Bighorn River	3,606	17,200	16,490	710	0	16,490	710	0
14e-37a	Two Leggins Irrigation Unit	27,085	113,090	108,350	4,740	4,740	108,350	4,740	4,740
14e-38	East Side Bighorn River	321	2,160	1,460	700	700	1,460	700	700
14e-40	Lower Tullock Creek	795	6,650	5,850	800	0	5,850	800	0
	Subbasin Total	56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
Little Bighorn Subbasin									
14e7-1	Little Bighorn River	6,773	50,800	50,800	0	0	50,800	0	0
14e7-2	Pass Creek	696	5,220	5,220	0	0	5,220	0	0
14e7-3	Lodge Grass Creek	2,234	11,470	11,470	0	0	11,470	0	0
14e7-4	Owl Creek	1,042	6,440	6,440	0	0	6,100	340	340
14e7-5	Little Bighorn-East Side	250	1,520	1,520	0	0	1,520	0	0
14e7-6	Little Bighorn-West Side	6,139	24,250	24,250	0	0	24,250	0	0
	Subbasin Total	17,134	99,700	99,700	0	0	99,360	340	340
Summary									
Stillwater Subbasin		29,252	175,110	175,110	0	0	175,110	0	0
Yellowstone Minor Drainages		39,951	253,670	252,920	750	0	252,920	750	0
Clarks Fork Subbasin		88,628	582,430	503,200	79,230	75,390	420,610	161,820	157,980
Bighorn Subbasin		56,454	270,420	260,280	10,140	5,440	255,670	14,750	10,610
Little Bighorn Subbasin		17,134	99,700	99,700	0	0	99,360	340	340
TOTAL		231,419	1,381,330	1,291,210	90,120	80,830	1,203,670	177,660	168,930

Source: River Basin Planning Staff

1/ Based on average annual consumptive uses. 2/ Diversions shown here do not exceed estimated diversion requirements. Actual diversions may exceed these amounts in dry years on streams where water supply is not limited. 3/ The exercise of water rights may create additional storage needs in some locations.

about 64 percent as much as that consumed by irrigated crops. Because of practical, political, and environmental limitations, overall phreatophyte control may not appreciably increase the water supply available for irrigation. Some of the lands they occupy may be capable of producing more valuable pasture, hay, or other crops than are produced by the phreatophytes. Areas of the phreatophytes are shown in table II-8.

FORESTED LAND PROBLEMS

Wood from forested lands makes only a small contribution to the local economy of the area. Scattered stands of low quality timber, inaccessibility, slow growth due to overcrowding, inadequate skilled woods workers, and lack of a processing plant for small material are all problems even though a market does exist in Billings and vicinity for finished wood products.

Many of the forested lands have been overgrazed in the past and some are still utilized beyond their safe carrying capacity. Overgrazing contributes to increased erosion, higher sediment yields, accelerated runoff causing higher peak flows in localized streams and generally poor watershed conditions.

Most of the problems on forested lands are related to recreation use or mineral exploration. Recreation-related problems include degraded water quality from increased sediment production and inadequate treatment of garbage, sewage, and waste water. Peak period demands for recreational facilities bring about some overuse of campsites, both developed and undeveloped. Recreational summer homes without adequate sewer systems are the greatest threat to water quality in the forested area. Subdivision of privately owned recreational lands is occurring on an unplanned, uncoordinated basis and is contributing to inflated land values. It is also causing heavy use on roads and trails and an increase in requests for special use permits on public lands for water systems, recreation, stock grazing, and rights-of-ways for roads and transmission lines. Increased recreational use greatly increases man-caused fire risks, pressures on fish and wildlife populations, littering, and trespass. Some mineral prospecting and mining operations have created large scars on the landscape, increased erosion and sediment yields, and left lands unproductive. Roads have been built into previously inaccessible country. Off-road vehicles entering this newly opened land often contribute to damage of fragile alpine soils and sparsely vegetated slopes by creating ruts which can channel water and become erosion gullies.

While there is access across some private lands to public lands, in many areas landowners refuse to sell or grant crossings or rights-of-way to public lands. This results in overuse of public lands in some areas with presently available public access.

Range and Forest Fires

Fire control within the national forest boundary is the responsibility of the Forest Service. Forest fire control on private and state timber lands is the responsibility of local fire districts in cooperation with the Office of the State Forester. Range fires on public domain lands are controlled by the Bureau of Land Management. Range fires on private land are generally fought by local residents, fire district members, and by Bureau of Land Management personnel if public domain is endangered. Forest fires in the region mostly start from lightning and the small acreage burned annually has not produced problems of any magnitude. Range fires usually cover large acreages and are more frequent because of the greater opportunities for man-caused fires. Uncontrolled range fires in semiarid areas destroy valuable forage and wildlife cover, increase runoff and subsequent erosion. A lack of recognition of fire as a tool in proper range and forest management has resulted in many acres of subclimax ecosystems. In turn, reduced forage production and increased erosion and sedimentation occur locally. On the average, 17 fires per year burn 95 acres of federal forested lands while six fires on Indian lands damage 644 acres each year. One hundred and sixty fires per year on state and other private forested lands burn an undetermined acreage.

POLLUTION

Water pollution in the Basin is not a serious problem at present except in localized instances. The larger towns have sewage lagoons while the smaller towns depend on private septic tanks. There is some danger of ground-water contamination and occasional stream pollution from improperly treated sewage. A common complaint is infiltration of ground water into the sanitary sewers in Absarokee, Red Lodge, Roberts, and Joliet. Sewage lagoon improvements are needed at Hardin, Lodge Grass, and Crow Agency. Most of the other towns have adequate systems. Feedlots along streambanks are an increasing potential source of pollution. Some fertilizer and agricultural chemicals are carried into the streams by sediment from overland flooding and by irrigation waste water. Past attempts to measure the intensity or change in agricultural chemical pollution have been inconclusive. Sediment is the greatest measurable pollutant. Silvertip Creek in Carbon County is being polluted with chemicals from the Elk Basin oil field to the extent that the Montana Animal Health Director recommends that cattle be kept from drinking it. Mine acid pollution has been identified by the Forest Service in the headwaters of the Stillwater River and in the Fisher Creek headwaters of the Clarks Fork River near Cooke City. Mine workings and tailings near Nye are a source of sediment and metals during periods of high runoff. Some communities discharge treated waste waters into streams, thereby increasing the organic load. Algae are abundant in the Bighorn River below Yellowtail Dam. This creates variations in oxygen balances and increases in turbidity.

FISH AND WILDLIFE PROBLEMS

Except for isolated areas in the higher mountains, nearly all habitat on both public and private land has been adversely affected to some degree by overgrazing and improper land use during the last 50 years. Big game are often in direct competition for forage with sheep, cattle, and horses, particularly for critical winter range. Overgrazing by both game and livestock has decreased the quality and quantity of forage and has accelerated erosion and sediment production. Sagebrush and weed control spraying may have had adverse effects on deer, antelope, sage grouse, and pheasant habitat. Deer population on the Indian reservation has been reduced beyond the optimum by overhunting to the extent that deer forage is going unused. There has been a decline in antelope numbers due to a combination of change in habitat and overharvest of game. In some areas predator control has brought an imbalance in natural wildlife populations with an overpopulation of rodents.

RELATIONSHIP OF WATER PROBLEMS TO IMPAIRMENT OF NATURAL BEAUTY

Problems related to the visual resource of the area's environment are not unique, but do exist and are the subject of increased concern by the public. Litter, junked cars, and cars used for riprap are examples of visual discord. Esthetic values are often damaged by alteration of the natural landscape. This problem is related to timber harvest, mining, and land clearing for pasture, cropland, transmission lines, and roads. Some water resource developments are unsightly unless provisions for esthetics are included in such items as vegetative plantings, road and overlook location, and careful recreational facility layout.

ECONOMIC PROBLEMS

Among the most pressing of the economic problems in the Basin is the human degradation resulting from poverty, unemployment, and underemployment of the Indians. About 32 percent of the land within the Crow Reservation boundary is no longer owned by the Indians. Some land went into roads and railroads and Bighorn Lake, but most was bought by white ranchers and farmers. The best cropland and ranchland is now in non-Indian ownership, leaving more marginal land to the Indians.

A higher percentage of the total potentially irrigable land has been developed off the reservation than has been developed on the reservation. This is partially explained by the difficulties in administration of multiple ownership of small tracts of land, limited Indian development capital, early sale of good lands to whites, and differences in economic pressures confronting Indians and non-Indians. For example, division of property rights among the heirs has progressed to the point that many tracts of land now have over 100 fractional owners. Administration or legal clearance for the development of such lands is almost impossible under present statutes. Even with maximum economic development of agricultural resources on Indian lands, the poverty would not

be solved because there is not enough economic base on those lands to support the 3,800 Indians living there. Other solutions must be found. There is a program with funds administered by FmHA called the Indian Lands Acquisition Loan Program. Under this program, tribal agencies can borrow funds to acquire ownership of multiple-owner tracts or of non-Indian tracts. Loans are for 40 years at 5 percent interest with repayment by first assignment of income from purchased lands and from assignment of other tribal incomes. At present, only one such loan has been made on the Crow Indian Reservation.

The Indian factors present some institutional barriers to development and social problems beyond the scope or intent of this investigation. Cultural attitudes concerning preparation for the future, incentives to save, concepts of time orientation, and the work ethic that are common to the non-Indian are alien to the older Indian culture. Indians who have adopted these white attitudes present fewer problems in adjustment than those retaining the Indian cultural attitudes.[1/] Paternalism of charitable organizations and the reservation system itself appear to hinder adjustment and assimilation of this minority group into the mainstream flow of our economic society.

Under the present system of small school districts, nearly all small towns have their own high schools. Local people complain that this causes higher property taxes than might otherwise occur, higher costs per student, and disadvantages to students in lower quality education than is available in larger high schools.

1/ Reifel, Ben; Indians of the Missouri Basin--Cultural Factors in Their Social and Economic Adjustment. Paper presented at MBIAC meeting at Aberdeen, South Dakota. May 14-15, 1958.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

This chapter describes the need for land and water resource development as related to problems, projected economic activity, and needs for environmental and social improvement. Project-type developments are needed to reduce flood damages in the town of Lodge Grass and the residential area along Blue Creek to the one percent chance level. Irrigation and drainage developments are needed to provide more efficient use of agricultural resources and provide for continued expansion of crop and livestock production which is projected to double by 2020. Both project and land treatment measures are needed to reduce erosion and sediment production to the lowest practical level to enhance water quality and preserve environmental resources. The increased production of crops and livestock is needed to improve the economic and employment base. This would improve the income per person (which is about 72 percent that of the national average) and decrease the 25 percent rate of chronic underemployment.

WATERSHED PROTECTION AND MANAGEMENT TO REDUCE EROSION AND SEDIMENT PRODUCTION

The high proportion of Basin lands with moderate and severe erosion hazards necessitates continued effort in watershed protection and management. On land inventoried in the 1970 Conservation Needs Inventory (CNI), 59 percent of the cropland and 74 percent of the rangelands have moderate to severe water or wind erosion hazards. Rangeland in particular is susceptible to severe water erosion hazard. Most public domain lands and large acreages of national forest lands are classified as range. By applying the CNI percentages of erosion hazards over all Basin lands, it is estimated that about 246,700 acres of cropland have moderate erosion hazards and 91,800 acres of cropland have severe erosion hazards. For rangeland, 677,600 acres have moderate hazards and 1,961,400 acres have severe hazards. It should be emphasized that erosion hazard classification does not indicate that moderate or severe erosion is occurring, but rather that such erosion would occur without careful management. On the basis of erosion hazards and land treatment needs, increased awareness and intensified vigilance in watershed protection and management are essential to prevent loss or deterioration of the land resource and to hold sediment production to the lowest practical minimum. See tables V-1 and V-2.

As recreation use increases, there will be a need to increase fire prevention and protection measures, improve roads and trails, provide adequate sewage treatment facilities, prevent overuse of recreational sites, and control off-road vehicular travel to maintain the environmental quality. More adequate laws are needed to control mineral exploration and extraction, to reduce damage to watershed cover and prevent erosion. Grazing lands should be managed for optimum use, but

TABLE V-1--CONSERVATION TREATMENT NEEDS ON STATE AND PRIVATE LANDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Treatment Category	Cropland Irrigated	Cropland Dryland	Range	Forest	Other Land 1/	Total 1/
	acres					
Treatment Adequate	10,692	138,376	968,570	238,550	18,543	1,374,731
Treatment Infeasible	0		94,158			94,158
Cropland Practices						
Cultural or Management Measures	23,933	206,180				230,113
Improved Irrigation Systems and Management	132,180					132,180
Irrigation Water Management Only	14,614					14,614
On-Farm Drainage Only	50,000					50,000
Pasture and Range Practices						
Needs Protection Only			1,558,602			1,558,602
Needs Improvement Only			79,226			79,226
Brush Control & Improvement			417,805			417,805
Reestablishment of Vegetative Cover			22,533			22,533
Reestablishment with Brush Control			1,085			1,085
Forest						
Establishment & Reenforcement of Timber Stands				9,060		9,060
Timber Stand Improvement				54,355		54,355
Other Land						
Needing Treatment					22,548	22,548
MONTANA TOTALS	231,419	344,556	3,141,979	301,965	41,091	4,061,010

Source: Conservation Needs Inventory 1970

1/ Water areas are excluded.

TABLE V-2--STATUS OF LAND TREATMENT NEEDS ON STATE AND PRIVATE LANDS 1/

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Land Use	Treatment Adequate	No Treatment Feasible	Treatment Needed	Total
	- - - - - - - - - - - - - - -	acres	- - - - - - - - - - - - - -	
Big Horn County				
Irr. & Dry Cropland	34,786		199,678	234,464
Pasture & Rangeland	347,524	54,580	1,466,924	1,869,028
Forested Land	147,785	--	14,920	162,705
Carbon County				
Irr. & Dry Cropland	61,015	--	117,939	178,954
Pasture & Rangeland	201,073	24,180	333,525	558,778
Forested Land	28,594	--	14,000	42,594
Stillwater County				
Irr. & Dry Cropland	11,303	--	32,034	43,337
Pasture & Rangeland	61,187	--	101,671	162,858
Forested Land	29,318	--	21,618	50,936
Treasure County				
Irr. & Dry Cropland	2,188	--	2,166	4,354
Pasture & Rangeland	37,498	2,453	35,645	75,596
Forested Land	3,730	--	9	3,739
Yellowstone County				
Irr. & Dry Cropland	39,776	--	75,090	114,866
Pasture & Rangeland	321,288	12,945	141,486	475,719
Forested Land	29,123	--	12,868	41,991
BASIN TOTALS				
Irr. & Dry Cropland	149,068	--	426,907	575,975
	(28%)	--	(72%)	(100%)
Pasture & Rangeland	968,570	94,158	2,079,251	3,141,979
	(31%)	(3%)	(66%)	(100%)
Forested Land	238,550	--	63,415	301,965
	(78%)	--	(22%)	(100%)

Source: River Basin Planning Staff

1/ Ratios of treatment needs to land use in County CNI data 1967 were applied to acreages of land used in private cropland, forested land, and grassland in the Basin.

there is a need to restore overgrazed lands and limit the number of grazing animals to the carrying capacity of the range. The meeting of the above needs will provide watershed protection by reducing damaging effects of fire, preventing overuse and misuse of the land and reducing erosion and sediment production on forest and rangelands.

In order to manipulate and manage grazing animals, adequate land treatment measures such as cross fences and stock water developments need to be established. This is essential in developing grazing management systems designed to improve range conditions and minimize erosion.

Establishment of management practices in the Basin should correspond with goals of the Montana Rangeland Resource Plan: (1) 80 percent of the range will be operated under some form of intensive management planning by 1980; (2) 80 percent of the range will be in good-to-excellent condition by 1980; and (3) 80 percent of the stock water developments will be installed by 1980.

Stock water developments and fencing needs on state and private rangeland, including Indian Trust lands, will be determined as individual management plans are developed.

Treatment needs on national forest rangeland are estimated at 5 stock water site developments and two miles of drift fence. Treatment needs on federal forested lands call for construction of 10 miles of multiple-use roads and 20 miles of recreational trails. No information of this type is available on state and private forested lands. There is a need to reduce the erosion from substandard forest roads, mining access roads, mineral exploration pits, inadequate trails, and from abandoned roads and trails. There is also a general need to rehabilitate abandoned mineral exploration and extraction areas. Quantification of land treatment needs to control erosion is shown in table VIII-3.

Locally, on BLM administered lands some roads will be taken out of general use and designated for fire control and other emergency uses.

On irrigated lands, improved irrigation systems with better waste water outlets are needed to reduce erosion and sediment production. On dry cropland, increases in stripcropping, stubble-mulching, grassed waterways, and regrassing of steep fields are needed to reduce erosion and sediment production. In some areas, there is a need to exclude cattle from erosive streambanks--both on private and public lands.

Land treatment measures can reduce sediment production. However, it must be realized that a large portion of the land area in the Basin is subject to erosion that is not caused by man's activities. High sediment concentrations are to be expected in some drainages. For example, on July 14, 1860, Lt. Maynadier observed the Clarks Fork River

and wrote, ". . .its waters being turbid, produces a slight discoloration in that of the Yellowstone." An excerpt from the Lewis and Clark journal:

> "July 24, 1806: The name of Clarks Fork was given to this stream. It is a bold river 150 yards wide at its entrance, but a short distance above is contracted to 100 yards. The water is of a light, muddy color and much colder than that of the Yellowstone."

Treatment measures in these areas could reduce total sediment production only by an insignificant amount.

FLOOD PREVENTION

Flood damage in the Basin has not been a major problem largely due to sparse population and intelligent location of most residences out of the flood plains. There is some urban flood damage along Rock Creek in Red Lodge that can be corrected with channel enlargement and flood diking or removal of residences from the damage area. The average annual value of these damages is not sufficient to justify the amount of single purpose storage above Red Lodge that would be required to rectify the problem. There is some flood damage to cabins and summer homes along the Stillwater River caused basically from encroachment on the flood plain. A similar situation exists along the Little Bighorn River and along Blue Creek and Pryor Creek except that these are year-round residences--mostly Indian residences on the Little Bighorn and Pryor Creek. There is need for flood prevention measures on Lodge Grass Creek and Blue Creek in order to prevent potential tragedy.

Land treatment in this part of the Basin would have very little effect on the total volume of runoff generated from high intensity storms and probably only minor effect on timing of the associated flood peaks. Floodproofing of some existing structures may have short-time local benefits. Riprap protection of bridges and critical highway areas is needed in conjunction with increased capacities in overflow channels and bridges in some areas. Flood plain zoning with strict enforcement to prevent further encroachment on flood plains and stream channels is needed to prevent damages to summer homes and residences. In conjunction with zoning, some existing buildings need to be removed from the flood plains of Blue Creek, Pryor Creek, Little Bighorn River, Rock Creek, and Stillwater River and its tributaries. These buildings and corrals not only receive damages, but endanger other properties by reducing channel capacities and contributing to debris dams.

DRAINAGE IMPROVEMENT

Drainage improvement is needed on 12,000 acres on Yellowstone Minor Drainages; 8,100 acres on the Clarks Fork Subbasin; 24,000 acres on the Bighorn Subbasin; and 5,900 acres on the Little Bighorn Subbasin to correct high water table conditions caused by insufficient outlet for irrigation waste waters and seepage from canals and irrigated

upper benches. Group action or project development will be needed for 33,000 acres where natural outlets to the rivers are either non-existent or are impaired by other developments such as highways and railroads. Alleviation of these high water table conditions is needed to accomplish the production efficiencies of resources committed to irrigated agriculture in these areas.

IRRIGATION

Based on water resource surveys by the Montana Department of Natural Resources and Conservation and updating by local technicians, there are 231,419 acres now irrigated in the Basin with an additional 41,750 acres potentially irrigable from existing irrigation canals. In addition to these potential acreages, the Bureau of Reclamation's Hardin Unit proposal contains 42,600 acres of irrigable land.[1/] The primary need in the irrigated sector is for improvement of irrigation delivery systems and on-farm irrigation systems and practices. Some areas need storage of spring runoff for late season use. Adequate water supplies and reasonable water use efficiencies are needed to achieve a profitable return to resources used in irrigation. Ditch consolidation and/or reorganization are needed to serve 77,000 acres in Carbon County; 20,000 acres in Stillwater County; 10,000 acres in Yellowstone County; and 44,000 acres in Big Horn County. The need for consolidation and reorganization in Big Horn and Yellowstone Counties is lower due to more irrigation development under larger projects than under small private diversions. Development in Carbon and Stillwater Counties was predominantly by individual or small group appropriation which resulted in multiple diversions and parallel ditch construction.

Stream gage records and simulation studies show that adequate full season water is available for irrigation systems under direct diversion from the Bighorn and Yellowstone Rivers. On the Little Bighorn, a full season supply is available more than eight years out of ten for currently irrigated acres and current irrigation efficiencies. On the Clarks Fork, a full season supply is available 50 percent of the years for current irrigated acres and efficiencies. Supply would be even more deficient if all irrigable acres are added. An irrigation study is needed on Rock Creek and the Clarks Fork River to determine present uses and needs. There are insufficient data on water diversions and uses to determine the extent and causes of reported shortages. Lands on the Stillwater drainage generally have sufficient water supply, especially if their irrigation efficiencies were improved.

1/ Total potentially irrigable land in the Basin is estimated at 485,150 acres as based on physical characteristics of the land. However, only a small portion of these acres is economically feasible to irrigate under current crop prices and development costs.

All of these water deficits could be corrected with storage of excess spring runoff. Storage sites need to be developed whenever economically feasible. Some of the deficits can be corrected with improved irrigation distribution and use efficiencies. The least costly approach may well be a combination of storage and improvement of distribution and on-farm efficiencies. On lower elevation tributaries where runoff yield is lower and less dependable, neither storage nor improved efficiencies will solve the deficits for very large acreages. Such areas will have to depend on pump lifts out of larger rivers or on water transported from adjacent drainages.

RURAL, DOMESTIC, AND LIVESTOCK WATER SUPPLY

Potable water for human consumption on farms and ranches is supplied largely by wells. In some areas on the heavier soils that were developed from marine shales, the ground water is too high in salts content for human use. Residents in an area from Yellowtail Dam to near Hardin have been exploring the feasibility of a water treatment plant and pipeline system to serve their farms. Another area with domestic water problems exists near Fromberg.

Livestock water development, including wells, spring developments, plastic pipelines, and possibly livestock pond lining, is needed to improve the livestock distribution on private and public range. These water developments, coupled with additional drift fences, can result in better utilization of the existing vegetation. Good range management is also needed to reduce erosion and sediment damages.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

At present, there is ample water for the towns in the Basin and for existing industry. The potential for new industry will largely depend on the pattern of steam-electric power generation in the eastern Montana-northern Wyoming coal region. Earliest development is expected to occur just east of the Basin. Water for this development may be transported from Bighorn Lake by a conduit now being planned. As steam-electric generation and associated development moves into the Basin, additional industrial water may need to be developed, but such needs are not expected before 1985-1990. Spin-off industrial development from low-cost at-site electricity could develop before that period.

Following an extended period of static production levels (ten year average annual production, 1958-67 was 354,102 tons/year), Montana coal production began to increase rapidly in 1968. By 1971 the production was 7,097,126 tons, 20 times the earlier annual average. All indications are that annual figures will show continued rapid increase. Neither state nor industry officials can predict when or at what level production will stabilize.

Year	Production (tons)	Year	Production (tons)
1958 1/	338,836	1966	415,410
1959	337,866	1967	364,509
1960	301,273	1968	555,271
1961	358,848	1969	1,024,885
1962	365,850	1970	3,517,158
1963	336,548	1971	7,097,126
1964	344,636	1972	8,044,815
1965	377,248		

1/ 1958-1971 figures from Biennial Reports of the Montana Board of Equalization/Department of Revenue
2/ 1972 preliminary estimate from Montana Department of State Lands

FORESTED LAND MANAGEMENT

There is a need to inventory the timber resources of commercial forest lands that are not within specially designated areas such as wilderness. The potential of these lands needs to be assessed on the basis of realistic and continuing silvicultural practices such as commercial thinning and reforestation. There is a need for a year-round wood processing plant in the Basin that could supply a portion of the Billings wood market and other local demands. A skilled force of woods workers and plant operators needs to be trained as part of any forest management program. A multiple use land management concept, including grazing, timber, water, fish and wildlife, and recreational uses, is needed for a successful forestry program.

RECREATION

Recreational needs within the Basin are more a function of forces outside the area than a function of local population and income factors. As the interstate highway system is completed, population increases, and vacation time and income per worker increase, there will be associated increases in recreational pressures. The western expanses of the United States such as the Basin with large areas of public land will have to absorb much of this national pressure. Local pressures will increase along with moderate increases in population, but are expected to be minor in comparison with national pressures on the area. Levels of recreational activity for the Basin are estimated in table V-3. Total use is projected to increase from 1,641,800 visitor days in 1970 to 2,068,700 visitor days in 2020, an increase of 26 percent. Recreation increase is taken to be a function of the increase in population within the area of influence, as projected by the OBERS report, and ignores changing influences outside the area of influence. It is assumed that participation rates will not increase and that the distribution of recreational demand

TABLE V-3--PRESENT AND PROJECTED RECREATIONAL NEEDS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Activity	Current	1985	2000	2020
	Visitor Days			
Boating				
Use	89,500	95,800	102,900	112,800
Supply	151,200	151,200	151,200	151,200
Needs	---	---	---	---
Swimming				
Use	71,500	76,500	82,200	90,100
Supply	94,500	94,500	94,500	94,500
Needs	---	---	---	---
Camping				
Use	853,900	913,700	982,000	1,075,900
Supply	345,700	513,700	513,700	513,700
Needs	508,200	400,000	468,300	562,200
Sight-Seeing				
Use	186,200	198,900	214,500	234,600
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Winter Sports				
Use	65,600	70,100	75,600	82,700
Supply	105,000	105,000	105,000	105,000
Needs	---	---	---	---
Hiking				
Use	18,600	19,900	21,400	23,400
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Fishing				
Use	172,200	184,300	198,000	217,000
Supply	210,000	210,000	210,000	210,000
Needs	---	---	---	7,000
Hunting				
Use	32,000	34,200	36,900	40,300
Supply	NA	NA	NA	NA
Needs	NA	NA	NA	NA
Picnicking				
Use	152,300	163,000	175,100	191,900
Supply	277,600	277,600	277,600	277,600
Needs	---	---	---	---
Total Demand	1,641,800	1,756,400	1,888,600	2,068,700

Source: River Basin Planning Staff NA = Not available

between Montana residents and nonresidents will not change, either. Demand figures may be low because of these assumptions and because the impact of coal strip-mining east of the Basin was not considered.

There is a need to recognize the fact that, for some people, the quality evaluation of the recreational experience will decline with increased development and subsequent increased recreational participation in what previously had been relatively unique activities. However, the sum value to all recreational participants may be greater after development than before development, depending on the degree of public saturation and destruction of the recreational resource.

Recreational supply in the Basin is also affected significantly by factors outside the area, specifically state and federal government attitudes toward recreational development. Historically, governmental funding for recreational facilities has not been adequate to meet the demands.

Recreational use in visitor days (12 hours of recreational activity) does not necessarily indicate the number of times that a particular activity was enjoyed; for example, one visitor day of picnicking may represent six people having one two-hour picnic, or one person having six two-hour picnics. One picnic unit could be occupied for each picnic.

Also, development of supply in visitor days assumes that a particular recreational unit is available for use during 12 hours each day. But a picnic table might be used only once (two-hour period) during a day.

Consequently, the recreational demand-supply situation as presented in tables V-3 and V-4 does not give an adequate description of recreational needs. Each visitor day may represent more than one recreational experience. As much as 80 percent of total use may occur during weekends. Additional water-based recreational facilities close to Billings would receive heavy evening and weekend use.

Striving to meet peak demands is economically inefficient due to the large percentage of idle capacity during the remaining periods. This factor, along with the lack of generation of revenue to government agencies and high maintenance costs, has limited public development of recreational facilities. Consequently, the actual demands for recreational facilities, particularly for swimming and camping, are in excess of supply; and increases in demand will greatly overtax existing recreational facilities on both public and private land to the point of damaging some facilities. Particular needs include increases in camping and trailer spaces, fishing and boating access areas and marinas, improved land access, and more swimming areas (tables V-3 and V-4).

TABLE V-4--EXISTING AND PLANNED RECREATIONAL FACILITIES
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Facility	Existing	Planned	Total	Total Additional Units Needed
Camping				
Federal (No. units)	475	400	875	1,210--1970
State "	53	NA	53	952--1985
Municipal "	6	NA	6	1,115--2000
Private "	289	NA	289	1,339--2020
	823	400	1,223	
Picnicking				
Federal (No. units)	245	200	445	NA
State "	222	NA	222	NA
Private "	138	NA	138	NA
Local "	56	NA	56	NA
	661	200	861	
Hiking - Unclassified				
Federal (Miles of trails)	54	NA	54	NA
State " "	NA	NA	NA	NA
Private " "	NA	NA	NA	NA
	54	NA	54	NA
Hiking - Classified				
Federal (Miles of trails)	135	NA	135	NA
State " "	NA	NA	NA	NA
Private " "	NA	NA	NA	NA
	135	NA	135	NA
Boat Launching				
Federal (No. sites)	4	NA	4	NA
State "	2	NA	2	NA
Private "	NA	NA	NA	NA
	6	NA	6	NA
Marinas				
Federal (No. sites)	0	1	1	NA
State "	0	NA	NA	NA
Private "	1	NA	1	NA
	1	1	2	NA
Observation Sites				
Federal (No. sites)	4	NA	4	NA
State "	NA	NA	NA	NA
Private "	NA	NA	NA	NA
	4	NA	4	NA

NA - Not Available

TABLE V-4--EXISTING AND PLANNED RECREATIONAL FACILITIES (Cont'd)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Facility	Existing	Planned	Total	Total Additional Units Needed
Winter Sports				
Federal (No. sites)	1	NA	1	NA
State "	0	NA	NA	NA
Private "	1	NA	1	NA
	2	NA	2	NA
Swimming				
Federal (No. sites)	1	NA	1	NA
State "	NA	NA	NA	NA
Private "	1	NA	1	NA
Local "	4	NA	4	NA
	6	NA	6	NA
Fishing Access				
Federal (No. sites)	20	NA	20	NA
State "	20	NA	20	NA
Private "	NA	NA	NA	NA
	40	NA	40	NA

Source: River Basin Planning Staff
NA = Not available

It should be pointed out, however, that 1970 excess recreational demands were met in some way and new facilities will have to compete with unorganized recreational supplies.

Increasing recreational pressure will require many new facilities, primarily on private lands. Private lands near public lands provide the best opportunities to develop these facilities as private business is then permitted to judge the economic feasibility of development. This is likely to be the only way in which recreational demands would be met due to the lack of public recreational construction funds. Public monies might be put to better use providing better access to public lands through more and better roads as well as improved public information. Privately developed facilities may better match demands than public development because private entrepreneurs tend to develop resources only to the extent that the recreating public will tend to pay for their use. In addition, emphasizing facility development on private lands while using public recreational funds to provide other types of recreational services will minimize the degree of economic competition between these two sectors. This factor should encourage private industry to meet the increasing

recreational demands. New unevaluated factors affecting recreational pressures on private lands include National Park policies of reducing and eventually eliminating camping facilities and the increased restriction of vehicular travel to designated roads and trails on public domain and National Forest lands.

Along with increased recreational use and development will come a greater need to control the location and distribution of use. This may require city and county zoning laws, better information of current use density and better recreational facility design and maintenance.

FISH AND WILDLIFE

Projected needs for recreational development point up the growing demand for fishing on streams and lakes. A large growth in fishing is also expected on Bighorn Lake and the afterbay below the dam. Storage of water in multipurpose reservoirs to maintain or augment live flows in trout streams or to provide permanent fish and wildlife pools should be considered wherever financial sponsors can be found to pay for the nonfederal share of installation and O&M costs for that purpose. Further benefits to fish and wildlife from sediment and erosion reduction by land treatment practices need to be publicized and encouraged.

Structural and vegetative works of improvement should include provisions for increased habitat for fish and wildlife as well as maintenance of existing habitat, particularly the preservation and enhancement of game winter range. Care should be taken so that the environmental quality of habitats located away from the project site, but influenced by the project, is not degraded by works of improvement. Interagency cooperation leads to better use of available fish and wildlife resources and provides for increased benefits. Special emphasis should be placed on fish and wildlife developments around dense population centers and heavily traveled tourist routes. Maintenance of existing fish and wildlife resources should have the same priority as expansion of new potentials.

Benefits from many fish and wildlife and recreational structural measures accrue more to people from outside the watershed than to people residing in the watershed in that waterfowl migrate to other areas and much of the fishing and camping is enjoyed by people from outside the watersheds. On this basis, there may be a good argument for amending existing legislation to provide greater cost-sharing for such construction and permission for fish and wildlife or recreation to be primary purposes in watershed projects. In many areas, extreme needs for water-based recreation can be found, particularly around population concentrations and in areas along the interstate highway system.

WATER QUALITY CONTROL

Present needs for the maintenance and improvement of water quality include the protection of high quality water for domestic, agricultural,

and recreational use and the improvement of lower quality water through sediment reduction and improved sewage treatment. The protection of streams includes prevention of pollution from human, agricultural, oil field, and mining sources. Human pollution occurs from incomplete treatment of sewage and encroachment of summer homes and septic tank drainfields on the narrow flood plains of mountain streams. Increased recreational use will require more and better designed facilities and management on both public and private lands to control pollution from human and animal wastes. Agricultural pollution consists of sediment from range and cropland, agricultural chemicals, and runoff and manure from feedlots. Continued vigilance and increased land treatment is needed to decrease erosion and sediment production. The higher use of fertilizer and pesticides presents a further need to reduce runoff and sediment that carry pollution into streams. Larger feedlots with less farm use of manure require sewage disposal systems or other measures to prevent pollution by livestock.

State water quality standards are established and implemented by the Montana Department of Health and Environmental Sciences with direction from the Montana Water Pollution Advisory Council. Under this authority, water quality standards have been developed and published along with policy statements adopted by the Council. These standards establish stream use classification, maximum allowable additives, minimum waste water treatment requirements, and reasonable measures to minimize sedimentation from man's activities. Thus, adequate laws and standards appear to exist. Enforcement may be quite another matter, especially where diffused sources are concerned. Funding for technical and enforcement personnel and funding for assistance in remedying existing violations of these standards may be a primary need in order to accomplish the goals of the legislation and the quality standards.

PROTECTION OF NATURAL BEAUTY

There is a growing need to provide for the esthetic as well as the economic and utility needs of water and land resource development projects. These needs include reclamation of strip mine and timber harvest areas, roadside plantings, and design of water storage and diversion structures to complement the natural surroundings. The need is not only to develop an awareness for the quality of visual resource, but to also utilize the skills of landscape architects and ecologists together with engineers in designing projects, related structures, and other land resource development projects to optimize the combination of outputs.

RURAL POWER SUPPLY

Adequate rural electric power is supplied by the Montana Power Company and various REA cooperatives within the Basin. Very little further expansion of electrical distribution is anticipated, although

total energy demand per person is expected to continue to increase . New hookups will consist largely of rural nonfarm residences, summer homes, and small industries. There may be some more disconnects as farms consolidate. Natural gas is supplied by the Montana Power Company and Montana Dakota Utilities Company to the towns and some farms lying along the gas line rights-of-way.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Many state and federal programs and projects supply technical services and financial assistance to meet resource management and development needs in the Basin. The public needs to be more aware of the services and assistance available and the degree to which these programs can be used to meet their needs. The present level of operation and funding of some of these programs is below that needed to meet present and early action resource development needs. A discussion of state and federal programs follows.

USDA PROGRAMS

Economic Research Service Programs

The Economic Research Service conducts national and regional programs of research, planning and technical consultation, and services pertaining to economic and institutional factors and policy which relate to the use, conservation, development, management, and control of natural resources. This includes their extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and the recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

SOIL CONSERVATION SERVICE PROGRAMS

PL-566 Projects and Programs

Applications for assistance under Public Law 566 have been received on four watersheds. Three of these are joint watersheds with Wyoming that are inactive at the present time--Sage Creek-Pryor Mountain (14e6-8), Crooked Creek (14e-27), and Cyclone Bar (14c-5). The application on Two-Leggins Canal (14e-37a) is still active and awaiting preliminary investigation. No other watersheds have been planned or constructed in the Montana part of the Basin. A flood hazard analysis is under way on the Stillwater River. This information will help prevent real estate speculation and retard residential development of the flood plain.

Resource Conservation and Development Projects

The Beartooth Resource Conservation and Development Project serves all of Carbon and Stillwater Counties in the Basin, a total of 1,786,824 acres or about 36 percent of the Montana Basin area. A resource conservation and development project is defined as a locally initiated and sponsored activity to expand the economic opportunities for the people

of an area by developing and carrying out a plan of action for the coordinated orderly conservation improvement, development, and wise use of their natural resources. The Resource Conservation and Development project is the local people's program--sponsored, developed, and carried out by the local people with assistance from all agencies of the local, state, and federal governments. Many of the subprojects under the RC&D are directly involved with water and land resource improvement and will benefit from investigation and analysis of this river basin study.

Assistance to Conservation Districts

Under authority of PL-46, the Soil Conservation Service provides a broad program of technical service to farmers and ranchers through the direction of Conservation Districts. These services include assistance in farm and ranch planning, installation of conservation practices, soil surveys, plant materials improvements, snow surveys, technical assistance to other USDA activities, and aid to other agencies responsible for administering conservation programs on private lands.

Under the Great Plains Conservation Program, the SCS provides technical assistance and cost sharing for water and land resource conservation measures with cooperating farmers under a Great Plains contractural arrangement. Part of the Great Plains agreement includes long-range continuing planning for the whole farm resources.

Conservation practices installed in the Basin with SCS assistance include: 54 miles of irrigation ditch improvements; 33,900 acres of land leveling; 35,513 acres of irrigation management systems; 154,000 acres of stubble mulching; 110,000 acres of stripcropping; 6,800 acres chiseling and subsoiling; 1,109 farm ponds; 1,912 spring and well developments; 57,200 acres of grazing management systems; 1,375 miles of fencing; 12,300 acres of brush control; and 12,000 acres of wildlife cover plantings. Advice is provided for erosion control connected with new construction of homes and highways. Technical assistance is provided for rural sewage disposal and pollution prevention measures for homes, rural towns, and feedlots.

Snow Surveys

Snow surveys provide an additional tool in water supply forecasting and more efficient water use and storage reservoir management.

The Montana and Wyoming Conservation Districts Plant Materials Center at Bridger, Montana, has developed several new plant varieties for general use over the years. Recently, the Center has been involved in selection of plant varieties for use in strip-mine reclamation and in development of a nonbloating milkvetch for pastures and a wheatgrass for roadside plantings and other critical erosion areas.

OTHER USDA PROGRAMS

Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service administers the various farm programs for wheat and feed grains, cropland adjustment, and price supports. The SCS provides the technical assistance needed for planning and installation of a number of conservation practices.

Farmers Home Administration

The Farmers Home Administration serves as the lending agency for a wide variety of loan programs ranging from annual production loans through farm purchase loans to watershed project loans. SCS cooperates with FmHA by providing the technical planning information to support loan applications for developments that deal with soil and water conservation measures.

Cooperative Extension Service

The Cooperative Extension Service disseminates educational and management information from research agencies, educational institutions, federal, state, and local agencies to landowners and other individuals. They provide leadership in 4-H youth programs, crop variety demonstration plots, and county fairs. Extension Service has the organizational leadership in the Community Rural Development (CRD) program, which assists rural people in identifying the services they need for economic, social, and cultural growth and helps them secure those services. Their basic service, in liaison with the experiment station laboratories and coordination of educational meetings, brings closer contact between rural people and their university system. The end result is faster distribution and demonstration of new technology than would otherwise occur.

Rural Electrification Administration

The Rural Electrification Administration provided loans for construction of rural electric association cooperative facilities and transmission lines and rural telephone systems throughout the Basin where such utilities were not available. Additional loans were available for farm electrification and household appliances. The Montana part of the Basin is served by the Beartooth, the Yellowstone, and the Big Horn Electric Cooperatives. For further relationship of USDA agencies and programs, see table VI-1.

Forest Service Programs

The West Fork of Rock Creek, which supplies water for the city of Red Lodge, is on National Forest land designated as a special "municipal watershed" administered by the Forest Service. In order to protect this

TABLE VI-1--USDA AGENCY PROGRAMS RELATED TO RESOURCE CONSERVATION NEEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	PROGRAMS OF AGRICULTURAL AGENCIES					
	Soil Conservation Service	Forest Service	Agricultural Stabilization & Conservation Service	Farmers Home Administration	Extension Service	Rural Electrification Service
Watershed Protection Management	PL-566,PL-46 PL-84-1021 RC&D PL-92-419	Clarke-McNary Act PL-91-224,PL-566 Coop. Forest Mgt. Act	RECP	PL-566,PL-87-128 FHA Act 1961	Smith-Lever Act Ag. Mkt. Act 1946	
Flood Prevention	do	do	RECP	do		
Land Stabilization	do	do	RECP	do		
Sediment Control	do	do	RECP	do	do	
Drainage Improvement	do	----	RECP	FHA Act 1961 PL-566; RC&D	do	
Irrigation	do	----	RECP	do	do	
Rural Domestic and Livestock Water Supply	PL-46 PL-84-1021 RC&D	do		FHA Act 1961 PL-46 PL-84-1021;RC&D	do	
Municipal & Industrial Water Supply	PL-566 RC&D PL-92-419	do		FHA Act 1961 PL-566 PL-92-419		
Waste Disposal	do	----	RECP	FHA Act 1961 PL-92-419	do	
Recreation	PL-566;PL-46 RC&D;PL-92-419 PL-84-1021	PL-90-542; RC&D PL-566; PL-91-606 N.F. Rec. Mgt.		PL-566 PL-92-419 RC&D	do	
Fish and Wildlife	do PL-91-559	N.F. Wildlife Mgt. PL-566;F.A.A. 1962	RECP PL-91-559	do	do	

TABLE VI-1--USDA AGENCY PROGRAMS RELATED TO RESOURCE CONSERVATION NEEDS (Continued)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	PROGRAMS OF AGRICULTURAL AGENCIES					
	Soil Conservation Service	Forest Service	Agricultural Stabilization & Conservation Service	Farmers Home Administration	Extension Service	Rural Electrification Service
Water Quality Control	PL-46;PL-566 RC&D PL-92-419	PL-91-224;PL-566;PL-91-606 Coop. Forest Mgmt. Act Clarke-McNary Act		FHA Act 1961 RC&D PL-92-419	Smith-Lever Act Ag.Mkt. Act 1946	
Rural Power Supply	----	----	----	----	----	REA
Forage Prod. and Range Mgmt.	PL-46 PL-84-1021 PL-566-RECP	PL-566 N. F. Range Mgt. Coop. Forest Mgt.	RECP		do	
Timber Production	RECP	Clarke-McNary Act N.F. Timber Mgt.;Coop. Forest Mgt.;Pest Cont. Act	RECP		do	
Fire Control		N.F.Timber Mgt; Coop. Forest Mgt.;PL-92-419				
Land Inventory & Monitoring	PL-46 PL-89-560 PL-92-419	PL-92-419				
Rural Development	RC&D PL-92-419	RC&D Coop. Forest Mgt.		PL-92-419 FHA Act 1961	do	

Source: Catalog of Federal Domestic Assistance

water supply, the watershed is managed under more rigid guidelines than are required on other adjacent National Forest lands. Continued special emphasis and management are needed to provide the degree of protection necessary for this high value watershed. The Forest Service manages much of the recreational resource adjacent to Yellowstone National Park and is responsible for management of the 230,000-acre Beartooth Primitive Area now under study for wilderness classification. These recreational resources have national significance because of their uniqueness and their proximity to Yellowstone National Park. In addition, the Division of State and Private Forestry of the Forest Service provides assistance to the Montana Department of Natural Resources and Conservation, Division of Forestry, in cooperative forest management, cooperative insect and disease control, and cooperative fire protection programs. They also provide assistance to CRD groups, other rural development programs, and PL-566 projects.

The Forest Service manages the National Forests under the Multiple-Use Sustained Yield Act and the Environmental Protection Act which provide for optimum and continued compatible uses of these public lands without degradation of the environment. One of the key roles of the Forest Service programs is to protect the upstream watersheds. This is accomplished through multiple-use plans, fire prevention, protection and suppression programs, watershed restoration projects, fire and flood rehabilitation projects, and reforestation programs. In addition, interdisciplinary planning and specialist skills are now employed to protect watershed and environmental values during road and trail construction, timber harvest, insect and disease control programs, recreational facility development, wildlife habitat rehabilitation projects, wilderness management, timber stand improvement programs and range management.

PROGRAMS OF OTHER AGENCIES

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA), of the U. S. Department of the Interior, administers Indian Trust lands and provides technical assistance and social services to Indians on the Crow Reservation. Indian Trust lands total 1,464,802 acres or 29.4 percent of the Basin in Montana.

The federal government's special programs for its Indian citizens, stemming from the trust relationship and the tax-exempt status of Indian Trust lands, are administered for the most part by the Bureau of Indian Affairs--an agency of the Department of the Interior. The one major program outside the Indian Bureau is the health and medical program for reservation Indians, which is under the direction of the Division of Indian Health, U. S. Public Health Service. The Division of Indian Health operates hospitals and clinics, provides sanitation services, and otherwise assists Indians with health and medical problems.

The programs of the Bureau of Indian Affairs include activities in education, social welfare, law and order, credit, housing, employment assistance, real property management, road construction and maintenance, soil and moisture conservation, range management, forest management, irrigation development and management, and other phases of economic development, including industrial development.

It should be emphasized that in nearly all these activities, the Bureau works closely with the tribal governments. Federal and tribal governments have a joint responsibility, and it is recognized that cooperation is essential to the effectiveness of any program. The Bureau's role in large degree is that of supplying to the Indian people the technical services provided elsewhere by other agencies.

The overall objectives of the Bureau of Indian Affairs are:

1. Maximum Indian economic self-sufficiency.
2. Full participation of Indians in American life.
3. Equal citizenship privileges and responsibilities for Indians.

The Bureau of Indian Affairs has conducted an intensive study of potential irrigation and recreation development on the reservation. Considerable work on range utilization improvement is under way with development of springs, wells, and pipelines for stockwater supplies and grazing dispersal. A recreational complex and a carpet factory have been developed at Crow Agency to improve employment opportunities. The Pretty Eagle recreational development near the north end of the Bighorn Recreational Area is nearing completion and will add to employment opportunities.

Irrigation development by the BIA started with the Reno Unit in 1885. This was followed by the Soap Creek Unit in 1894 and other units in later years for a total of eleven units under the Crow Irrigation Project. The largest of these units is the Bighorn Canal Unit with 21,800 acres irrigated. Total land irrigated in Big Horn County amounts to 63,058 acres, including the private development of 14,100 acres under the Two-Leggins Canal. All development is from direct diversion except for offstream storage in the Willow Creek reservoir near Lodge Grass.

Bureau of Reclamation

The Bureau of Reclamation's Yellowtail Dam and reservoir and the proposed Hardin Unit irrigation project dominate the current water development scene in Big Horn County. The dam was completed in 1967 and provides storage capacities of: 259,000 acre-feet for flood control; 250,000 acre-feet for joint use flood control and conservation; 364,000 acre-feet of conservation storage; 483,000 acre-feet of inactive storage; and 19,000 acre-feet of dead storage for a total capacity of 1,375,000 acre-feet. Historical average annual streamflow at the dam site is 2,531,000 acre-feet.

The 42,600 acres of irrigation on the Hardin Unit are expected to use 131,700 acre-feet of diverted water with a net depletion of about 68,500 acre-feet with 63,200 acre-feet of return flows.

The largest subscribed nondepleting water use is hydro-electric power generation. An additional 623,000 annual acre-feet are contracted for coal gasification and steam electric generating companies for use in northeastern Wyoming and southeastern Montana. In addition, further requests are pending for 967,000 acre-feet for industrial use.

The Huntley Irrigation Project was started in 1905 in Yellowstone County. Water is diverted from the Yellowstone River about 15 miles east of Billings. About 29,240 acres are irrigated by this project.

Bureau of Land Management

The Bureau of Land Management (BLM) of the Department of the Interior has the responsibility for administering the use of public domain lands and for conservation measures and land treatment on lands in the Bighorn Canyon National Recreational area. The BLM administers 215,033 acres in the Montana part of the Basin. They have conducted an intensive study of these lands and prepared a Land Planning and Classification report in 1953. More recently they have applied land treatment practices toward erosion reduction and better range use. The BLM is employing the multiple use concept of public lands and is developing some recreational facilities. Preservation of the fragile desert ecology will be an increasing problem as recreational use increases. Some effort is under way to identify and preserve archeological sites in the Pryor Mountain area. A study funded jointly by the BLM, National Park Service (NPS), and Forest Service has begun inventorying the archeological resources of the Basin. Preliminary findings show that the resource is extensively distributed throughout the Basin and that there has been prolonged human habitation. Much of the resource is found in remote areas and remains in good condition. Efforts to control the use of this resource should be made to prevent destruction of this historical component of the Basin.

National Park Service

The National Park Service has prepared plans for and is proceeding with development of the Bighorn Canyon National Recreational Area. Part of the road system and boat launching facilities are completed. Campground facilities will probably be kept at a minimum and restricted mostly to the fringes of the area. Recreational developments on Indian Trust lands are the responsibility of the Tribal Council with assistance from the Bureau of Indian Affairs. Similar developments on Public Domain lands near the canyon area are the responsibility of the Bureau of Land Management. These are largely limited to overlooks on the wild horse range, road designation, and land use control measures.

Bureau of Outdoor Recreation

The Westwide Report on the Critical Water Problems of the Eleven Western States (Review Draft May 1974) indicates that the Secretaries of Agriculture and Interior recommend 5(a) study status under the Wild and Scenic Rivers Act for the Yellowstone River from Yellowstone Lake to Pompeys Pillar, including its Clarks Fork tributary.

A recent 5(d) study conducted by the Bureau of Outdoor Recreation in cooperation with other federal and state agencies concluded that most of this reach of the Yellowstone River met the criteria for designation under scenic or recreational rivers. Further study with extensive public involvement would be required before a recommendation for designation in the National Wild and Scenic River System could be made.

A bill to establish a State system of wild and scenic rivers was defeated in the 1975 session of the Montana Legislature. Most of the opposition came from farmers and ranchers concerned about access to the rivers for maintenance of existing diversions as well as construction of future diversions. Because of opposition to a State system which would have included this reach of the Yellowstone, Montana is withholding support of the 5(a) classification pending an indication of local public support. This is particularly necessary in the Yellowstone case where over 90 percent of the lands bordering the river are in private ownership.

The local position will be determined through a series of public meetings in the Basin.

Other streams in the Basin that might also be studied for designation as a part of the wild river system include:

Lake Fork Rock Cr. above national forest boundary,
West Fork Rock Cr. above national forest boundary,
East Rosebud Creek above Alpine,
West Rosebud Creek above Mystic Lake, and
Forks of Stillwater River above national forest boundary.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

Few of the streams listed above are well suited to recreational use for floating. Use of the Clarks Fork, Bighorn, and Yellowstone Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

STATE PROJECTS AND PROGRAMS

The Montana Department of Natural Resources and Conservation operates Cooney Reservoir for irrigation and recreation. Total storage at Cooney is 27,515 acre-feet, of which 24,200 acre-feet are used for supplemental irrigation further down Red Lodge and Rock Creeks. This was the first "Water Board" project in Montana and was financed in part by a grant from Public Works Administration.

The Montana Department of Fish and Game has developed recreational facilities at Cooney Reservoir and at fishing access sites along Rock Creek, Stillwater River, and Bighorn River. They have developed a state fish hatchery on Bluewater Creek, using high quality spring water for the hatchery and rearing ponds. Additional lands were acquired along Bluewater Creek and developed as a fishing access.

All rangeland conservation practices planned for the Basin comply with implementation plans and goals of the Montana Rangeland Resource Plan. That program is a coordinated effort to emphasize the importance of rangeland to all people and the effect of rangeland management on economic activity, watershed protection, and environmental enhancement. For more orientation on state programs, see table VI-2.

The Conservation District programs are available for the entire Basin in Montana. Districts involved include Big Horn Conservation District, Carbon Conservation District, Stillwater Conservation District, Treasure County Conservation District, and Yellowstone Conservation District.

PRIVATE DEVELOPMENTS

There are numerous private water developments under organized ditch companies and by individual diversions. Part of the water use problems stems from too many small diversions and small ditches with high transmission losses, particularly on the Rock Creek and Stillwater River drainages. In Stillwater County, ten ditch companies and 46 private ranches divert water from the Stillwater River and its tributaries. In Carbon County there are 37 ditch companies and a total of 2,101 water rights filings. Nearly all the ditch companies have their own diversions and headworks. Many of the small private appropriators have diversion ditches with or without diversion dams. Rough topography, small acreages served, differences in appropriation priority dates, and personal prides tend to hinder further ditch consolidation or improvements in structural measures and transmission efficiencies. Most of the water lost from ditch seepage returns to the stream system and is rediverted farther on downstream. Thus, the overall stream system efficiency is not as low as it first appears, even though dewatering occurs in short reaches of many smaller streams.

TABLE VI-2--STATE AND LOCAL AGENCY PROGRAMS RELATED TO RESOURCE PROBLEMS AND NEEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Conservation Need	State of Montana and Political Subdivisions
Watershed Protection and Management	Department of Natural Resources and Conservation - Title 89, Chapters 1 and 35, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947 Cities, Towns, & Counties--Title 89, Chapter 33, R.C.M. 1947
Flood Prevention	Department of Natural Resources & Conservation--Title 89, Chapters 1 and 35, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947 Cities, Towns, & Counties--Title 89, Chapter 33, R.C.M. 1947
Land Stabilization	Department of Natural Resources & Conservation--Title 28, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947
Sediment Control	Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947
Drainage Improvement	Conservation Districts--Title 89, Chapter 34, R.C.M. 1947 Drainage Districts--Title 89, Chapters 22 through 28, R.C.M. 1947 Department of Natural Resources and Conservation--Title 89, Chapter 1, R.C.M. 1947
Irrigation	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Irrigation Districts--Title 89, Chapters 12 through 21, R.C.M. 1947
Rural, Domestic, and Livestock Water Supply	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947 Conservancy Districts--Title 89, Chapter 34, R.C.M. 1947

TABLE VI-2--STATE AND LOCAL AGENCY PROGRAMS RELATED TO RESOURCE PROBLEMS AND NEEDS (Continued)

Conservation Need	State of Montana and Political Subdivisions
Municipal and Industrial Water Supply	Department of Natural Resources & Conservation--Title 89, Chapter 1, R.C.M. 1947 Cities and Towns--Title 11, Chapter 9, R.C.M. 1947 Dept. of Health & Environmental Sciences--Title 69, Chapter 49, R.C.M. 1947
Waste Disposal	Cities and Towns--Title 11, Chapters 9 and 22, R.C.M. 1947 Department of Health & Environmental Sciences--Title 69, Chapters 48 through 50, R.C.M. 1947
Recreation	Department of Natural Resources and Conservation--Title 89, Chapter 1, R.C.M. 1947 Department of Fish and Game--Title 26, R.C.M. 1947 Conservancy District--Title 89, Chapter 34, R.C.M. 1947
Fish and Wildlife	Department of Fish and Game--Title 26, R.C.M. 1947
Water Quality Control	Department of Health and Environmental Sciences--Title 69, Chapter 48, R.C.M. 1947 Department of Natural Resources and Conservation--Title 69, Chapter 29, R.C.M. 1947
Rural Power Supply	None--all private
Forage Production and Range Management	Department of Natural Resources and Conservation--Title 46, Chapter 23, R.C.M. 1947 Grazing Districts--Title 46, Chapter 23, R.C.M. 1947
Timber Production	Department of Natural Resources & Conservation--Title 28, Chapter 1; Title 81, Chapter 14, R.C.M. 1947
Fire Control	Department of Natural Resources & Conservation--Title 28, Chapter 1; Title 81, Chapter 14, R.C.M. 1947
Land Inventory and Monitoring	Department of Natural Resources and Conservation--Title 28, Chapter 1; Title 89, Chapter 1, R.C.M. 1947 Counties--Title 11, Chapter 6, R.C.M. 1947 Conservation Districts--Title 76, Chapter 1, R.C.M. 1947
Rural Development	Rural Improvement Districts--Title 16, Chapter 16, R.C.M. 1947

Source: Montana Department of Natural Resources and Conservation.

Related land resource developments are rapidly increasing in the Basin, especially in the areas of recreation and minerals. Because of the attractiveness of the area, subdivisions for year-round and part time occupancy homes are increasing in number. The proximity of private lands to the more esthetic recreational resources provides opportunity for development of high quality private recreational facilities at reasonable costs. In addition, these developments lessen the pressure of recreationists on public facilities. Also, it broadens the area absorbing the recreational burden. Expanded mineral exploration is under way by the mining industry, and extraction may increase if market conditions continue to make it economically feasible. The recent interest in this area has stemmed from increased mineral prices and improved mineral retrieval technology.

Recreational and mineral developments impose related environmental and service costs on area users. If these effects are not minimized, many of the Basin's desirable attributes may be jeopardized.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

This chapter describes the capability of the Basin to supply water and land resources in terms of physical development potential for meeting identifiable needs. These potentials are not aligned with specific projects and programs, but are identified with particular problems and needs.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

In Montana's part of the Basin, about 485,150 acres of irrigable land have been identified.[1/] This acreage includes 12,833 acres in the Stillwater Subbasin; 159,556 acres in the Yellowstone Minor Drainages; 56,523 acres in the Clarks Fork Subbasin; 187,886 acres in the Bighorn Subbasin; and 68,352 acres in the Little Bighorn Subbasin. This acreage includes 41,750 acres that can be irrigated from existing canals and 42,600 acres of dry cropland and range that could be brought under irrigation by development of the Bureau of Reclamation's Hardin Unit. Considerable additional acres can be brought into irrigation with extension of existing canals or development of some pump-lift units. Big Horn County leads in potential irrigable acres--both under existing ditches and under new project units. The Bureau of Indian Affairs reports a total potential in Big Horn County of 89,776 acres, including the Hardin Unit. Many of the irrigable acres can be irrigated from pump-lifts, new diversions, and ditch extensions. The gradual shift to sprinkler irrigation, that is partly caused by lack of skilled irrigators, will tend to bring more lands into irrigation that were previously considered too steep or too uneven to be classed as irrigable. See table VII-1 and map II-7.

There is some potential for irrigation development from either storage or ground-water development near Sage Creek. Recent investigation in this area shows 14,576 acres irrigable with an 80 percent chance supply of 13,240 acre-feet from surface water and an unknown supply of ground water. Distribution of land ownership in the Sage Creek area and program restrictions may preclude project-type development, but may not restrict independent private development.

1/ Potentially irrigable acres as identified here include areas of soils with physical characteristics of texture, structure, slope, and chemical and climatic make-up that would produce satisfactory sustained yields if placed under irrigation. The economic analysis of providing the water storage or delivering it to these acres is completed for only the most practical developments.

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Watershed Number	Watershed Name	Irrigable Land (Acres) [1/]	Estimated [2/] Net Irrigation Needs Per Composite Acre (Acre-Inches)	Estimated [3/] Irrigation Depletion (Acre-Feet)	Estimated [4/] Diversion Requirements (Acre-Feet)
	Stillwater Subbasin				
14b-1	Upper Stillwater River	199	11.70	194	970
14b-2	Fishtail to Butcher Cr.	7,825	15.00	9,781	39,124
14b-3	Lower Stillwater River	3,383	15.00	4,229	14,097
14b-4	Shane-Beaver Creek	1,426	18.00	2,139	7,130
	Subbasin Total	12,833	15.28	16,343	46,694
	Yellowstone Minor Drainages				
14-22	Cow-Bellion Cr.	3,187	18.00	4,781	15,937
14-27	Blue-Duck Cr.	22,845	18.00	34,268	97,909
14-31	Arrow Cr.	10,839	18.96	17,126	48,931
14-33	Fly Creek	26,427	18.96	41,755	119,300
14-36	Lost Boy Creek	7,668	19.56	12,499	35,711
14-37	Custer Drainage	2,481	20.04	4,143	11,837
14d-1	Upper Pryor Creek	51,185	18.00	76,778	219,366
14d-2	Lower Pryor Creek	34,924	18.00	52,386	130,965
	Subbasin Total	159,556	18.33	243,736	609,340
	Clarks Fork Subbasin				
14c-3	Clarks Fork-Zimmer Creek	---	---	---	---
14c-4	Pat O'Hara Creek	---	---	---	---
14c-4a	Big Sand Coulee	1,353	20.04	2,260	9,040
14c-5	Line Creek	---	---	---	---
14c-6	N.F. Cherry-Silvertip Creek	12,056	19.56	19,651	65,503
14c-7	Clarks Fork-Ruby Creek	10,449	19.56	17,032	48,663
14c-8	Upper Rock Creek	590	11.64	572	2,860
14c-9	Red Lodge-Rock Creek	13,089	12.96	14,136	56,544
14c-10	Elbow-Lower Rock Creek	5,699	19.56	9,289	26,540
14c-11	Lower Clarks Fork E. Side	13,287	19.56	21,658	61,880
	Subbasin Total	56,523	17.96	84,596	211,490

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS (Continued)

Watershed Number	Watershed Name	Irrigable Land (Acres) 1/	Estimated 2/ Net Irrigation Needs Per Composite Acre (Acre-Inches)	Estimated 3/ Irrigation Depletion (Acre-Feet)	Estimated 4/ Diversion Requirements (Acre-Feet)
	Bighorn Subbasin				
14e6-8	Sage Creek	14,576	18.96	23,030	65,800
14e6-8a	Dry Creek	---	---	---	---
14e-27	Crooked Creek	125	18.96	198	660
14e-28	Porcupine Creek	---	---	---	---
14e-30	Dryhead Creek to Wyoming	9,603	18.96	15,172	50,573
14e-31	Black Canyon Cr.	---	---	---	---
14e-32	Soap Creek	8,509	19.56	13,870	39,629
14e-33	Beauvais Creek	39,706	19.68	65,118	217,060
14e-34	Rotten Grass Creek	15,656	19.80	25,832	73,806
14e-35	Two Leggins-Woody Cr.	22,925	19.92	38,055	126,850
14e-36	Warren Bench	2,265	20.04	3,782	10,806
14e-37	West Side Bighorn River	31,679	20.04	52,904	132,260
14e-37a	Two Leggins Irr. Unit	2,719	20.04	4,540	11,350
14e-38	E. Side Bighorn River	10,256	20.04	17,128	42,820
14e-39	Upper Tullock Creek	13,752	20.04	22,966	91,864
14e-40	Lower Tullock Creek	16,115	20.04	26,912	89,707
	Subbasin Total	187,886	19.77	309,507	687,793
	Little Bighorn Subbasin				
14e7-1	Little Bighorn River	7,277	18.00	10,916	36,387
14e7-2	Pass Creek	---	---	---	---
14e7-3	Lodge Grass Creek	13,079	18.48	20,142	57,549
14e7-4	Owl Creek	8,600	18.48	13,244	37,840
14e7-5	Little Bighorn E. Side	11,144	18.96	17,608	50,309
14e7-6	Little Bighorn W. Side	28,252	18.96	44,638	111,595
	Subbasin Total	68,352	18.71	106,572	236,827

TABLE VII-1--POTENTIAL IRRIGABLE LANDS AND WATER REQUIREMENTS BY SUBBASINS (Continued)

Watershed Number	Watershed Name	Irrigable Land (Acres) 1/	Estimated 2/ Net Irrigation Needs Per Composite Acre (Acre-Inches)	Estimated 3/ Irrigation Depletion (Acre-Feet)	Estimated 4/ Diversion Requirements (Acre-Feet)
	Summary				
Stillwater Subbasin		12,833	15.28	16,341	46,689
Yellowstone Minor Drainages		159,556	18.33	243,722	609,305
Clarks Fork Subbasin		56,523	17.96	84,596	211,490
Bighorn Subbasin		187,886	19.77	309,542	687,871
Little Bighorn Subbasin		68,352	18.71	106,572	236,827
TOTAL		485,150	18.82	760,773	1,792,182

Source: River Basin Planning Staff

1/ Irrigable land is identified only by slope and physical soil characteristics that would sustain irrigated cropping--not by economic feasibility.

2/ See Table VII-2.

3/ Total depletion is estimated to be from 120% to 130% of the irrigation depletion.

4/ Diversion requirements were determined from estimated project efficiencies adjusted with consideration of waste water reuse.

In some areas there is still potential for conversion of range to dry cropland as evidenced by changes noted between the last two aerial photo coverages. On cropable sites with adequate moisture and soils, the economic margin between returns from fallow-dryland cropping and dry range is heavily in favor of cropping. Most of these convertible lands are in Big Horn and Yellowstone Counties. Based on class II and III land in the changing area now used in range, there may be as many as 100,000 acres that can be profitably converted from range to dry cropland.

Availability of lands for residential, industrial, or recreational purposes may be in competition with agriculture. Because of economies in simplicity of street and utility installation, the most nearly level lands with good internal drainage are most desirable for urban and industrial tract development. These same general conditions are desirable for irrigation development. Returns in income and personal satisfaction are consistently higher for land used in urban and industrial development than for land in agricultural production. Even though conflicts in land use may occur, there is ample land to satisfy both agricultural and nonagricultural purposes in the Basin. Recreational uses of land are more apt to compete with range and timber production. Recreational uses of water tend to compete with irrigation diversions and storage drawdowns in multiple use reservoirs.

AVAILABILITY OF WATER FOR POTENTIAL DEVELOPMENT

In general, there is sufficient water yield in the Basin and subbasins to provide a full water supply to the economically irrigable acres.1/ However, there is a seasonal and a locational maldistribution of this water in relation to its time and area of need. Surplus spring runoff flows into the Yellowstone unused. More of this early flow could be stored for late summer use. Some canals can be enlarged and extended to serve more acres. Nearly all canals can be improved to decrease the heavy transmission losses now occurring. Some inter-subbasin transfers may be desirable. Irrigation of most of the potentially irrigable acres would require some combination of early flow storage, building of long canals, and construction of expensive pump lifts. The high cost of storage reservoirs and water conveyance systems in comparison with increased returns from irrigation is the most limiting factor in further irrigation expansion. Irrigable lands lying under existing canals or that can be served by extending existing canals offer the best potentials for added irrigation development. Most of the lands being irrigated need land treatment to improve on-farm irrigation efficiencies. There may be some potential for snowpack management and weather modification

---

1/ Economically irrigable land is that which can be brought under irrigation at an average annual total cost lower than the average annual value of increased production that is directly attributable to that irrigation.

TABLE VII-2--NET INCHES OF IRRIGATION WATER NEEDED BY CROPS IN A NORMAL YEAR TO PROVIDE FOR THEIR CONSUMPTIVE USE OF MOISTURE 1/

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

CROP	AREA						
	HARDIN	BRIDGER	HUNTLEY	BILLINGS	COLUMBUS	WYOLA	RED LODGE
	inches						
Alfalfa	22.2	22.1	21.9	21.4	20.2	19.8	12.8
Dry Beans	13.1	13.6	12.9	12.3	12.7	12.9	11.7
Sugar Beets	19.6	20.0	19.4	19.1	17.5	17.2	8.1
Silage Corn	15.6	15.4	15.2	14.9	13.9	13.6	8.6
Sweet Corn	13.7	14.1	13.3	12.8			
Small Grain	12.6	13.1	13.0	11.4	11.6	11.9	10.1
Grass	19.2	19.3	18.8	18.3	17.6	17.1	10.5
Peas		11.7	11.0	10.5			7.8
Potatoes	18.8	18.8	18.6	18.2	17.8		11.8

Source: River Basin Planning Staff

1/ Effective rainfall has been subtracted from gross crop water requirements.

to increase winter precipitation on selected drainages to help augment late season water supplies. Through a combination of storage of excess early runoff, canal combination and improvement, and improved on-farm irrigation systems and management to improve overall irrigation efficiencies, it appears physically possible to provide a full supply of irrigation water to all economically irrigable acres in the Basin. Quantities of water available in streams are shown in table IV-6 and figure VII-1.

There is a power reservation site on East Rosebud Creek above the Weast Canal diversion. No data are readily available on its kilowatt potential, but the estimated cost per acre-foot of storage is quite low ($25/acre-foot) and the 80 percent chance water yield is estimated at 116,000 acre-feet. As a nonconsumptive use, hydroelectric generation makes multiple-use storage of early season runoff that much more economical. After it passes through the turbines, this water can be used for irrigation or other purposes.

There is potential demand for a peaking-power hydroelectric dam in the Clarks Fork Canyon in Wyoming. The Bureau of Reclamation has estimated that this site has 177,500 kilowatts potential. Such a dam would also have recreational and irrigation water stabilization benefits. Economic and ecological arguments favor harnessing flow resources for hydrogeneration over using available stock resources of fossil and fission fuels. It is worth noting, however, that hydropower will fall far short of meeting the ultimate power needs of the whole region and would constitute only a fraction of the needs of the nation. A combination of hydro- and steam-electric power, water for industrial use, attractive climatic conditions, and recreational potential may encourage further light industrial development in the Basin.

There is ample high quality water that can be developed for municipal or industrial use in most of the Basin. In some parts of the Bighorn and Clarks Fork valleys, the ground water contains an excessive amount of dissolved salts and cannot be used for human consumption. Rural domestic supplies might be developed in those areas where population densities are high enough to keep the cost per family from being prohibitive. Unsubscribed water that could be used for industrial development is still available in Yellowtail Reservoir.

Storage of water for use outside the Basin is an important consideration. Coal-energy development in southeastern Montana will create high value usage of much water available in the overall Yellowstone drainage. Stored water from a dam in Clarks Fork Canyon might well be put to use in energy plants farther down the Yellowstone. The cost and value of water would seem to be the ultimate determining factor in the case of local use versus distant use. The federal government might well have to consider an ordering of priorities related to the highest use and need. Little, if any, water would be utilized for coal energy development inside the Basin.

IMPOUNDMENTS

Potential impoundments in the Montana part of the Basin or potential changes in existing impoundments are shown in the following table. The watershed location, principal purposes, capacity in acre-feet, annual water yield, and estimated cubic yards of fill are shown for individual structure sites. Several high mountain lakes in the Beartooth Primitive Area were identified for potential storage of spring runoff for late summer use. These sites were first located on topographic maps and aerial photos and then viewed from helicopter by a team of planners. No detailed investigations have been made of these sites. The potential for their development would be to provide late summer water for irrigation, municipal water, and streamflow augmentation. At present there are no known sponsors for their development. Construction and operation would present special problems in costs and environmental protection, but in several areas of the west these high mountain reservoirs are very beneficial. Presidential or Congressional action would be required to develop these sites. These sites can be identified on table VII-3 and map VII-1.

CHANNEL IMPROVEMENTS AND LEVEES

The only channel improvements identified in watershed investigations for flood prevention are the short reach of Rock Creek as it passes through Red Lodge, the short reach of West Rosebud Creek as it passes through Fishtail, Blue Creek near Billings, and Lodge Grass Creek as it passes through the town of Lodge Grass. In these cases there is either a lack of feasible storage sites to provide sufficient control close enough to the damage area or insufficient average annual damages to justify high storage costs. In each case, diking is needed to provide the one percent chance level of protection for urban areas required by PL-566 guidelines.

Some stream reaches along the Little Bighorn need stabilization to stop bank erosion that now endangers Indian homes. Some of these houses might be relocated out of the flood plain.

WATER TABLE CONTROL

Drain outlets and on-farm drainage, combined with more efficient irrigation management and distribution, have a potential to reduce high water tables in irrigated areas. Most of the areas needing drainage have soils suitable for irrigation that can be treated with individual or small group action. A few areas may be served by project action similar to that requested by the Two Leggins Canal irrigators (14e-37a). Much canal consolidation and lining can be done on a project basis to reduce water losses and seeped areas.

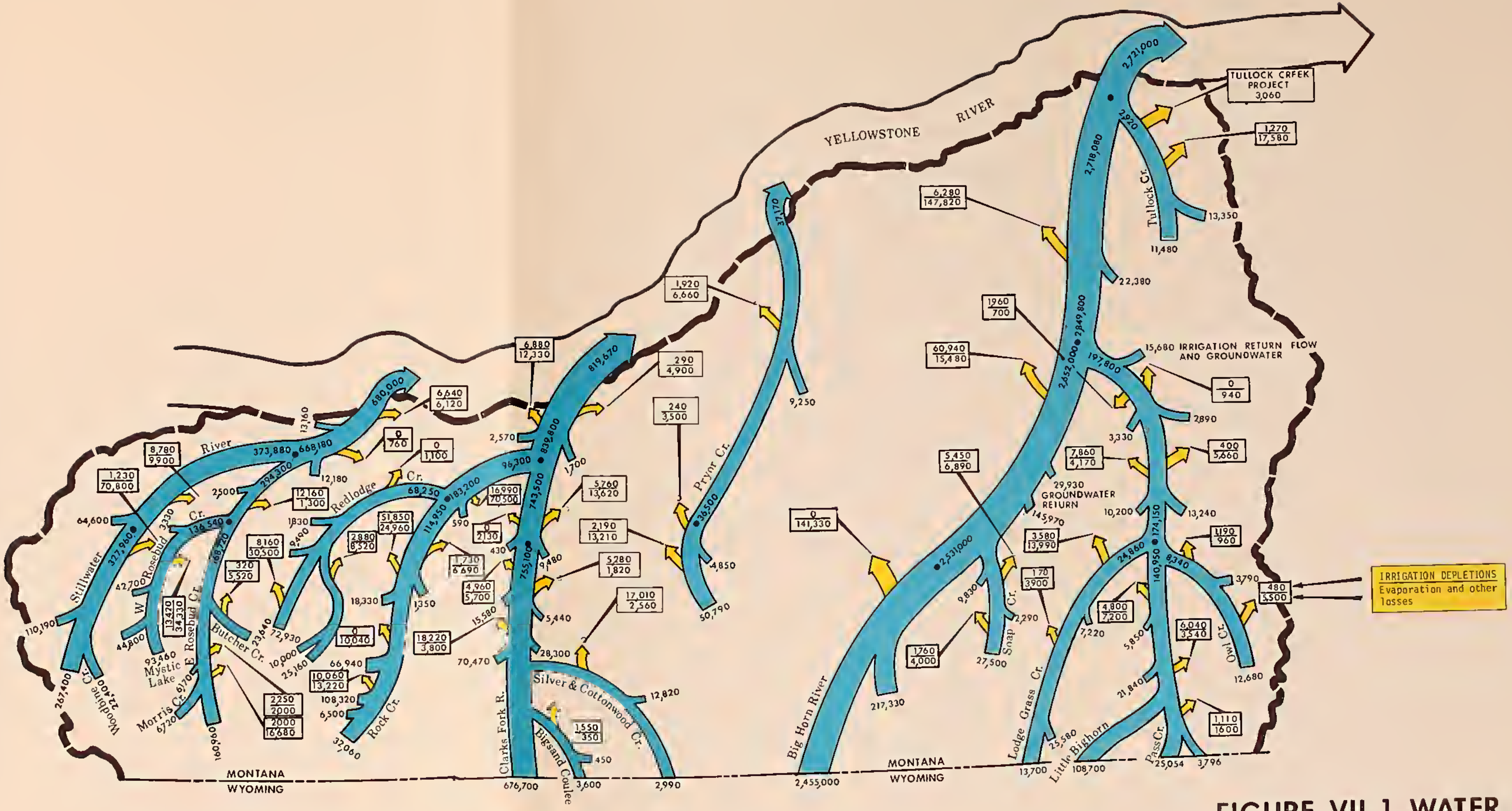
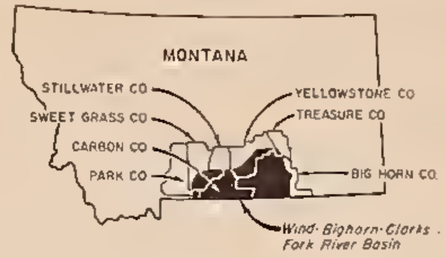


FIGURE VII-1 WATER BUDGET FLOW CHART

WATER YIELD AND DEPLETIONS

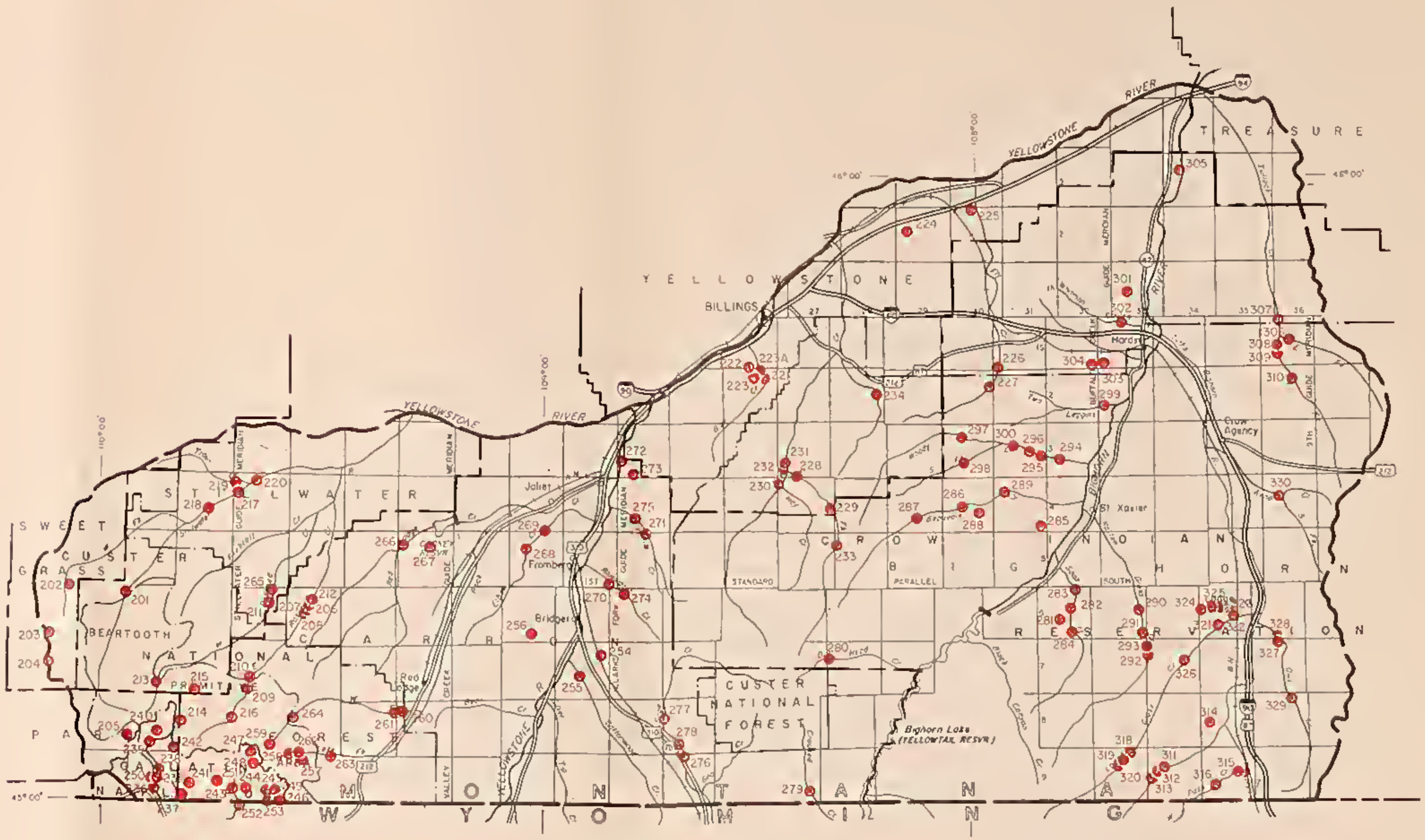
(ACRE FEET — ANNUAL YIELD)



LOCATION MAP

300 KNOWN RESERVOIR SITES

SEE TEXT FOR LISTING OF INDIVIDUAL RESERVOIR SITES



MAP VII-1

KNOWN RESERVOIR SITES

WIND-BIGHORN-CLARKS FORK RIVER BASIN

MONTANA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22914N-N

TABLE VII-3--PROBABLE RESERVOIR SITES

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Water-shed No.	Watershed Name	Site Name	Reservoir Map Index Number	Location: Township	Location: Range	Location: Section	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft) 1/	Reservoir Water Depth (Feet) 2/	Top Length of Embankment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embankment to Storage Ratio (Cu.Yd./Ac-Ft) 3/	Project Purpose Use 4/	Data Source Number 5/	Additional Storage Capacity Available (Ac-Ft)
Stillwater Subbasin																
14b-1	U. Stillwater R.	Sioux Charley L.	201	6S	15E	7	98,560	205,000	24,500	115	1,580	1,380,000	56	R,1,F	1,5,2	
		Lightning Cr. 6/	202	6S	13E	2	820	2,600	1,675	25	80	4,400	2.6	I	1,6	
		Wounded Man L. 6/	203	6S	13E	34,35	1,984	6,609	1,560	30	100	7,238	4.6	I	1,6	
		Pentad L. 6/	204	7S	13E	15	576	1,990	1,140	30	120	9,212	8.1	1	1,6	
		Goose L. 6/	205	8S	15E	19	1,728	6,476	2,370	20	100	4,140	1.7	I	1,6	
14b-2	Fishtail to Butcher Cr.	Sand Ford	206	6S	18E	9	71,070	142,000	37,420	70	1,500	420,000	11	P,R	2	
		E. Rosebud Cr. #1	207	6S	18E	16,9	71,070	142,000	25,000	52	1,100	144,000	6	I	1	25,000+
		E. Rosebud Cr. #2	208	6S	18E	16,17	71,070	142,000	25,000	56	1,590	318,000	13	1	1	
		E. Rosebud L.	209	7S	17E	29	47,380	118,000	25,000	90	2,460	1,300,000	52	R,I	1,2	5,000+
		E. Rosebud L.	210	7S	17E	21			1,200					P	5	
		W. Rosebud Cr. #1	211	6S	17E	2	58,880	128,000	25,000	149	2,250	3,460,000	138	R,I	1	10,000+
		Roscoe	212	6S	18E	9			6,800					I	5	
		Silver L. 6/	213	7S	15E	22	11,008	29,336	2,320	40	310	28,202	12.1	I	1,6	
		Cairn L. 6/	214	8S	16E	18	832	3,325	1,195	10	80	1,187	0.9	I	1,6	
		Turgulse L. 6/	215	7S	16E	33	1,792	6,865	3,015	30	140	12,017	4.0	I	1,6	
		Rainbow L. 6/	216	8S	16E	13	22,016	73,340	1,640	20	80	3,450	2.1	I	1,6	
14b-3	L. Stillwater River	Beehive #1	217	4S	17E	17,18	258,600	323,000	292,710	320	1,150	11,000,000	38	I,P	2	
		Beehive #2	218	4S	16E	22	236,610	315,000	301,061	233	2,410	7,900,000	26	I,P	2	
		Trout Cr.	219	4S	17E	6	16,960		7,800	130	620			I	5	
		Upper Stillwater	220	4S	17E	4	277,120		9,000	80	830			I	5	
Yellowstone Minor Drainages																
14-27	Blue-Duck Cr.	Blue Cr. #2	221	2S	26E	2,11	37,360	3,870	7,920	97	2,200	850,000	107	R,1,F	1	
		Basin Cr. #1	222	1S	26E	33	3,293	300	710	69	539	279,639	394	R,F	1	3,000+
		L. Basin Cr.	223	2S	26E	3,10	1,996	200	380	45	657	127,838	336	F	1	1,200
		Big Coulee	223A	2S	26E	2	2,450	240	580	41	470	25,800	45	F		
14-31	Arrow Cr.	Arrow Cr. #1	224	2N	29E	17	18,140	1,500	4,680	59	1,800	590,000	126	R,1,F	1	
14-32	Fly Cr.	Fly Cr. #1	225	2N	30E	4	162,140	13,500	25,000	55	1,770	1,039,900	42	R,I,F	1	35,000
		Fly Cr. #2	226	1S	31E	31	47,880	4,000	11,700	34	2,505	347,845	30	R,1,F	1	40,000+
		Fly Cr.	227	2S	30E	12									4	
14d-1	Upper Pryor Cr.	E.F. Pryor #1	228	4S	27E	5	51,670	8,600	17,100	75	2,650	1,180,000	69	R,1,F	1	40,000
		E.F. Pryor #2	229	4S	27E	24	38,700	6,500	13,100	84	2,210	1,400,000	107	R,1,F	1	23,000
		Hay Cr.	230	4S	27E	6	20,580	3,430	6,930	83	1,680	820,000	118	R,1,F	1	7,000
		Pryor Cr. #1	231	3S	27E	30,31,32	212,888	23,000	21,500	77	3,665	1,000,000	47	R,I,F	1	30,000
		Pryor Cr.	232	3S	27E	29,30	205,440	34,600	21,500	75					4	
		E.F. Pryor Cr.#1	233	5S	28E	7									4	
14d-2	Lower Pryor Cr.	E.Fork Cr. #1	234	2S	28E	13									4	
Clarks Fork Subbasin																
14c-3	Clarks Fk.-Zimmer Cr.	Broadwater Curl L.	235	9S	15E	15			9,300	50	1,000			1	5	
		Kersey L. 6/	236	9S	15E	27	1,984	4,131	2,710	20	100	3,822	1.4	I	1.6	
		Fox L. 6/	237	9S	16E	30	16,000	55,965	9,895	65	450	103,662	10.5	I	1,6	

TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Water-shed No.	Watershed Name	Site Name	Reser-voir Map Index Number	Location: Town-ship	Location: Range	Location: Sec-tion	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft) 1/	Reservoir Water Depth (Feet) 2/	Top Length of Embank-ment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embank-ment to Storage Ratio (Cu.Yd./Ac-Ft) 3/	Project Purpose Use 4/	Data Source Num-ber 5/	Additional Storage Capacity Available (Ac-Ft)
14c-3	Clarks Fk.-Zimmer Cr.	Broadwater L. 6/	238	9S	15E	10,15	11,776	46,093	4,260	30	110	12,702	3.0	I	1,6	
		Lower Aero L. 6/	239	8S	15E	28	2,880	11,992	6,400	25	150	9,770	1.5	I	1,6	
		Upper Aero L. 6/	240	8S	15E	22	1,472	6,129	4,950	20	300	13,792	2.8	I	1,6	
		Canyon L. 6/	241	9S	16E	19,20	4,672	17,509	1,513	25	110	6,357	4.2	I	1,6	
		Upper Russell Cr. L. 6/	242	8S	15E	36	1,216	5,063	1,416	40	140	19,273	13.6	I	1,6	
		Lake Elaine 6/	243	9S	17E	18,19	1,728	6,476	5,420	40	450	31,783	5.9	I	1,6	
		Green L. 6/	244	9S	17E	20	8,512	34,026	1,675	25	500	30,166	18.0	I	1,6	
		Golden L. 6/	245	9S	17E	23,26	2,240	7,835	1,410	20	100	4,830	3.4	I	1,6	
		Albino L. 6/	246	9S	17E	25	576		3,150	30	320	36,187	11.5	I	1,6	
		above Flat Rock L. 6/	247	8S	17E	33	832	3,465	1,640	40	100	12,840	7.8	I	1,6	
		Flat Rock L. 6/	248	9S	17E	4	3,328	13,858	1,740	30	100	9,869	5.6	I	1,6	
		Jasper L. 6/	249	9S	17E	23	1,792	6,268	1,680	20	200	10,699	6.3	I	1,6	
		Curl L. 6/	250	9S	15E	15	16,000	60,000	7,950	40	110	19,005	2.4	I	1,6	
		Jorden L. 6/	251	9S	16E	14	3,008	12,525	1,560	30	100	9,208	5.9	I	1,6	
		Granite L. 6/	252	58N	106W	21,22 7/	20,992	28,670	5,440	20	120	6,550	1.2	I	1,6	
		Lonesome L. 6/	253	9S	17E	35	576	1,967	1,230	30	80	5,918	4.8	I	1,6	
14c-6	N.F. Cherry-Silvertip Cr.	Bridger Cr. #1	254	7S	23E	12	19,390	2,700	6,160	74	1,100	632,836	103	R,I,F	1	25,000
		Cottonwood Cr. #1	255	7S	23E	21	73,670	3,100	15,900	88	1,400	842,423	53	R,I,F	1	30,000+
14c-7	Clarks Fk.-Ruby Cr.	Sand Cr. #1	256	6S	22E	34	6,100	500	1,740	48	783	167,226	96	R,I,F	1	25,000+
14c-8	Upper Rock Cr.	Black Canyon 6/	257	9S	18E	5	2,800		5,100	400	800			I	5	
		Second Rock Cr. 6/	258	8S	18E	31	3,950		740	25	450			I	5,6	
		Third L. 6/	259	8S	17E	35	700		2,100	40	370			I	5	
		W.F. Rock Cr. #3	260	8S	20E	6			3,000					I	5	
		W.F. Rock Cr. #4	261	8S	20E	6			6,900					I	5	
		Keyser Brown L. 6/	262	8S	18E	32	7,500		500	35	340			I	5	
		Lake Cr. #5 6/	263	9S	18E		550		1,600	150				I	5	
		Quinnebaugh Meadows 6/	264	8S	18E	7	9,800		3,000	95				I	5	
14c-9	Red Lodge-Rock Cr.	W. Red Lodge Cr.	265	6S	17E	12	29,990	12,500	16,400	103	2,200	2,500,000	153	R,I,F	1	20,000-
		Red Lodge Cr.	266	5S	20E	6,7	83,470	19,500	25,000	102	2,480	2,500,000	100	R,I,F	1	14,000+
		Willow Cr. #2	267	5S	20E	10,11	31,490	13,800	17,820	98	1,730	1,500,000	84	R,I,F	1	
14c-10	Elbow-Lower Rock Cr.	Elbow Cr. #1	268	4S,5S	22E,22E	35,2	24,320	4,900	11,700	91	2,300	884,700	76	I	1,5	30,000+
		Elbow Cr. #2	269	5S	22E	9,16	22,890	3,800	7,620	81	1,730	596,726	78	R,I,F	1	3,000
14c-11	Lower Clarks Fk. E. Side	Bluewater Cr.	270	5S	23E	35	29,060	23,300	11,955	105	1,500	1,250,000	104	R,I,F	1	8,045
		Five Mile Cr.	271	5S	24E	4	22,840	5,300							1	
		Cottonwood Cr. #1	272	3S	24E	19,30	29,390	2,000	7,300	82	1,155	600,000	82	R,I,F	1	
		Cottonwood Cr. #2	273	3S	24E	33	24,090	2,000	6,250	62	1,395	412,626	66	R,I,F	1	15,000+
		Bluewater Cr.	274	6S	24E	5			3,250	100				I	5	
		Five Mile Cr.	275	4S	24E	29	9,600		1,500	60	800			I	5	
Big Horn Subbasin																
14e6-8	Sage Creek	Sage Creek #1	276	9S	25E	4	101,760	10,200	25,000	82	2,050	1,300,000	52	R,I,F	1	20,000
		Sage Cr. #2	277	8S	25E	18	76,570	9,500	21,000	51	4,390	1,050,000	50	R,I,F	1	
		Sage Cr. #3	278	8S	25E	28,32,33	84,570	17,000	25,000	75	2,310	695,616	28	R,I,F	1	10,000+
14e-27	Crooked Creek	Crooked Cr. #1	279	9S	27E	26	27,590	4,600	8,010	91	2,407	1,606,019	200	R,I,F	1	10,000
14e-30	Dry Head Cr. to Wyo.	Dry Head Cr. #1	280	7S	28E	7	13,900	4,100	5,810	132	718	1,096,491	189	R,I,F	1	40,000+

TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Water-shed No.	Watershed Name	Site Name	Reser-voir Map Index Number	Location: Town-ship	Location: Range	Location: Sec-tion	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft)1/	Reservoir Water Depth (Feet) 2/	Top Length of Embank-ment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embank-ment to Storage Ratio (Cu.Yd./Ac-Ft)3/	Project Purpose Use 4/	Data Source Num-ber 5/	Additional Storage Capacity Available (Ac-Ft)
14e-32	Soap Creek	W.F. Soap Cr. #1	281	6S	32E	21	10,700	3,100	4,980	81	1,263	666,652	134	R,I,F	1	5,000
		Soap Cr. #1	282	6S	32E	15	59,180	20,400	25,000	82	3,270	2,054,290	82	R,I,F	1	10,000
		Soap Cr. #2	283	7S	32E	2	36,090	12,900	19,000	91	2,220	1,871,000	99	R,I,F	1	
		Soap Cr.	284	6S	32E	34									4	
14e-33	Beauvais Cr.	Hay Coulee	285	4S	31E	36	11,100	3,000	5,140	67	2,130	529,577	103	R,I,F	1	5,000+
		Beauvais Cr. #3	286	4S	30E	21	76,870	24,000	25,000	76	2,720	1,112,957	45	R,I,F	1	15,000+
		Beauvais Cr. #4	287	4S	29E	21,27	49,280	16,400	25,000	84	2,715	2,221,944	89	R,I,F	1	10,000
		Muddy Cr. #1	288	4S	30E	23	19,190	5,600	9,080	54	1,497	455,782	50	R,I,F	1	10,000
		Beauvais Cr.	289	4S	31E	8									4	
14e-34	Rotten Grass Cr.	Rotten Grass #1	290	6S	33E	13	58,580	24,900	25,000	87	3,350	2,499,560	100	R,I,F	1	
		Rotten Grass #3	291	6S	33E	36	45,780	20,000	25,000	99	4,000	3,100,000	124	R,I,F	1,4	
		Rotten Grass #4	292	7S	34E	7	42,780	19,300	25,000	91	3,600	2,017,352	81	R,I,F	1	
		Rotten Grass	293	7S	34E	6,7	49,920	12,600	14,000	77	2,800				4	
14e-35	Two Leggins-Woody Cr.	Woody Cr. #1	294	3S	32E	29	97,060	15,400	25,000	72	2,000	1,136,384	46	R,I,F	1	2,500
		Woody Cr. #2	295	3S	31E	24	90,560	14,300	25,000	74	2,395	1,356,856	55	R,I,F	1	25,000
		Woody Cr. #3	296	3S	31E	14	85,370	13,500	25,000	62	2,340	837,744	34	R,I,F	1	25,000
		Big Woody Cr. #1	297	3S	30E	9	33,490	6,100	14,500	49	2,040	462,416	32	R,I,F	1	20,000+
		Little Woody Cr. #1	298	3S	30E	21,27	21,290	4,000	9,000	49	2,035	303,829	34	R,I,F	1	21,000
		Two Leggins Cr. #1	299	2S	33E	19,20	34,490	4,300	10,650	74	1,731	909,165	85	R,I,F	1	7,000
		Woody Cr.	300	3S	31E	16									4	
14e-37	West Side Bighorn R.	Lone Tree Coulee	301	1N	33E	20	11,520	960	3,340	48	2,170	340,000	102	R,I,F	1	
		Whitman Coulee	302	1S	33E	9	20,460	1,700	5,600	54	1,520	436,000	78	R,I,F	1	1,700
		Williams Coulee #1	303	1S	33E	31,32	26,190	2,200	6,900	50	1,910	554,671	80	R,I,F	1	10,000
		Williams Coulee #2	304	1S	32E	36	23,690	2,000	6,500	44	1,435	352,532	54	R,I,F	1	
14e-38	East Side Bighorn R.	Custer	305	3N	34E	8	14,304,000		501,000	115	3,650			F,P	5	
14e-39	Upper Tullock Cr.	E.F. Tullock Cr. #1	306	1S	36E	15,22	32,890	4,100	9,800	63	2,320	524,987	54	R,I,F	1	15,000
		Tullock Cr. #1	307	1S	36E	5	142,087	6,963	19,358	60	3,300	680,000	35	I	1	
		W.F. Tullock Cr. #1	308	1S	36E	20	99,260	12,400	25,000	67	2,695	877,559	35	R,I,F	1	15,000+
		Tullock Cr.	309	1S	36E	29	86,400	4,135	34,000	65	3,800				4	
		W. F. Tullock Cr. #2	310	2S	36E	10	75,070	9,400	22,500	67	2,735	1,105,880	49	R,I,F	1	20,000+
Little Bighorn Subbasin																
14e7-1	Little Bighorn R.	Little Bighorn	311	9S	34E	17	129,280	106,000	70,000	138	3,000				4	
		Little Bighorn #1	312	9S	34E	17	134,450	115,400	25,000	110	1,900	1,684,870	67	R,I,F	1	100,000+
		Little Bighorn #2	313	9S	34E	19,20	133,450	115,000	25,000	98	2,520	2,150,000	86	R,I,F	1	100,000+
		Crazy Head Cr. #1	314	8S	35E	20	8,000	1,300	2,916	72	1,510	535,000	184	R,I,F	1	15,000+
14e7-2	Pass Creek	Pass Cr. #1	315	9S	35E	14	42,680	16,900	24,600	97	2,455	2,500,000	101	R,I,F	1	
		W. Pass Cr. #1	316	9S	35E	28,29	21,990	9,200	12,730	98	1,465	1,060,000	83	R,I,F	1	10,000+
		Pass Cr.	317	9S	35E	14	44,800	26,231	13,600	76	2,625				4	

TABLE VII-3--PROBABLE RESERVOIR SITES (Continued)

Water-shed No.	Watershed Name	Site Name	Reser-voir Map Index Number	Location: Town-ship	Location: Range	Location: Sec-tion	Drainage Area (Acres)	Estimated Annual Yield (Ac-Feet)	Storage Capacity (Ac-Ft)1/	Reservoir Water Depth (Feet) 2/	Top Length of Embank-ment (Feet)	Estimated Embankment Volume (Cu.Yd.)	Embank-ment to Storage Ratio (Cu.Yd./ Ac-Ft)3/	Project Purpose Use 4/	Data Source Num-ber 5/	Additional Storage Capacity Available (Ac-Ft)
14e7-3	Lodge Grass Cr.	Lodge Grass Cr. #1	318	9S	33E	2,3	41,780	31,000	25,000	157	1,290	1,720,000	69	R,I,F	1	
		Lodge Grass Cr. #2	319	9S	33E	10	40,180	30,500	25,000	153	2,800	2,800,000	112	R,I,F	1	10,000+
		Lodge Grass Cr. #3	320	9S	33E	9	38,290	29,800	25,000	155	2,700	3,700,000	148	R,I,F	1	10,000+
		Lodge Grass Cr. #4	321	6S	35E	28,29	96,160	39,800	25,000	80	3,830	1,850,000	74	R,I,F	1	7,000+
		Lodge Grass Cr. #5	322	6S	35E	15,22	108,780	40,800	25,000	75	3,300	1,809,330	72	R,I,F	1	8,000+
		Good Luck Cr. #1	323	6S	35E	16,17	9,560	800	3,000	50	1,390	370,000	123	R,I,F	1	10,000+
		Good Luck Cr. #2	324	6S	35E	18	7,580	650	2,158	52	1,315	368,000	171	R,I,F	1	2,800+
		Good Luck Cr. #3	325	6S	35E	17	8,596	725	1,440	38	1,350	290,000	201	F	1	4,600
		Lodge Grass Cr.	326	7S	34E	14									4	
14e7-4	Owl Cr.	Owl Cr.	327	7S	36E	4	100,000	10,000	37,500	95	3,000				4	
		Owl Cr. #1A	328	7S	36E	4	102,760	6,700	25,000	80	2,400	1,507,420	60	R,I,F	1	30,000+
		Owl Cr. #2	329	8S	36E	2	50,580	4,000	12,750	65	1,360	531,895	42	R,I,F	1	20,000+
14e7-5	Little Bighorn E. Side	Reno Cr. #1	330	4S	36E	17	37,890	1,800	8,500	72	2,810	630,000	74	R,I,F	1	12,000+

1/ Represents increased storage on wilderness study area sites.
2/ Represents increased water depth on wilderness study area sites.
3/ A comparative figure derived from dividing the estimated earth fill in cubic yards by the estimated water storage capacity in acre-feet.
4/ I--irrigation; F--flood protection; R--recreation (fishing, hunting, and boating); S--water supply (industrial, municipal, and domestic); P--power.
5/ Source: 1--Soil Conservation Service, 2--Bureau of Reclamation, 3--Corps of Engineers, 4--Bureau of Indian Affairs, 5--Montana Department of Natural Resources and Conservation, 6--Forest Service.
6/ Sites in wilderness study area.
7/ In Wyoming.

Irrigation diversion on Rock Creek above Red Lodge needs to be replaced. SCS PHOTO 11-P869-5

Golden Ditch diversion out of Clarks Fork River before reconstruction, 1959.
SCS PHOTO 11-6115-1

Golden Ditch diversion after reconstruction, 1961, eliminating annual diking and pollution of the river.
SCS PHOTO

IRRIGATION SYSTEMS

Improvement of distribution systems and consolidation of canals offer the best potential for more efficient water use. Present conveyance efficiencies as low as 40 percent were measured at the first farm turnout. In other words, 60 percent of the water diverted from the stream is lost from the canal before it reaches the first farm. Additional losses occur on down the canal, making the distribution efficiency even lower. Significant water savings could be realized on individual units from improvements in conveyance or farm application. Much of this "lost" water finds its way back into the stream through ground-water recharge and is diverted again and again until the stream leaves the Basin. Under present economic conditions extensive canal lining or piping of irrigation water is not feasible. Part of the diverted water is lost from the Basin through deep percolation and nonproductive phreatophytic transpiration. It is estimated that actual savings of water from canal lining in the Basin would amount to 12,600 acre-feet and another 21,000 acre-feet would be saved from improvement of on-farm efficiencies.

On-farm efficiencies range from 15 to 60 percent for flood and row-crop irrigation with the typical efficiency of about 30 percent. On-farm efficiencies depend on irrigation management practices dealing with soil permeability and water-holding capacity, slope of field, degree of uniformity, length of irrigation run, and skill of the irrigator. Only the last three of these factors have much potential for change and the last factor appears to be deteriorating.

As time goes on, more and more sprinkler irrigation is being used to offset the shortage of skilled irrigators. Investment per acre in conventional sprinkler systems tends to approximate the cost of land leveling and ditch preparation. Further investment in automated central pivotal systems greatly exceeds conventional sprinkler systems. Labor, power, and maintenance costs per acre on conventional sprinkler systems tends to exceed the variable costs of conventional flood or row-crop irrigation. The added amortization and maintenance costs on the large automated systems more than offset the savings in labor costs over conventional sprinklers at the present time. In addition, the rates of water application at the outer end of the pivotal boom are higher than the intake rates of the soil, resulting in runoff and inefficiency. On the basis of these comparisons, it appears that more conventional wheel move laterals or hand move sprinkler systems should come into use. With adoption of sprinklers, there comes a degree of built-in water management, less need for land preparation, and some increase in land areas irrigated that were in ditches before or too uneven for flood and row-crop irrigation. On-farm irrigation efficiency will increase as the number of sprinkler irrigation systems increases. Other increases in irrigation efficiency may be achieved through farm ditch lining and improved irrigation management education.

DEVELOPMENTS FOR RECREATION--FISH AND WILDLIFE

Development potentials in recreation can be broken into two categories. The first would consist of improving use of existing resources and the second would consist of new development. Improved accessibility to public lands and fishing waters is needed and can be accomplished by providing for walking access along banks of prime trout streams, lakes, and reservoirs and acquiring access across private land. This approach would entail more legal and legislative participation along with purchase of rights-of-way. Total investment in physical and depreciable structures would be low.

New development potentials would consist of new reservoirs, new roads and trails, new dude ranch type developments, and new campground facilities. Most of these items will require considerable capital investment and will have relatively high operating, maintenance, and replacement costs. Much of the success of this second category investment will depend on the accomplishments under the first category.

Grazing rights often have been interpreted by ranchers as rights to exclude all other users from the multiple use of federal and state lands. In many places the only practical entry to public land is across private ownership land. If the multiple use of public lands concept is to be realized, then access needs to be acquired through either negotiations or court action. There is a potential for providing much additional recreational opportunity at a relatively small annual cost.

Except for licensed fish ponds, trout water and the fish therein are generally considered state-owned property. Yet a very high proportion of the bank miles is posted private lands. There is a good potential for developing fisherman access paths along these streambanks and lakeshores with only minimum competition with agricultural uses. Such access logically should be governed and policed by the Montana Department of Fish and Game. Costs for acquiring the rights-of-way easements and building fence stiles and parking areas might be shared between federal and state funds. Some other states have acquired fisherman walkway easements. See table VII-4.

New developments should include consideration of recreational and fish and wildlife water storage with financial support from state and local agencies. There are good potential sites for either public or private campground development on or near public lands. Because of the problems associated with attempting to meet outdoor recreation demands as discussed in chapter five, the best opportunities to meet expanding demands will be through improvement of access to public lands and provision of developed facilities by the private sector. By doing this, the recreationists will pay the relatively high costs of providing the facilities they desire while maximizing opportunities to recreate for all persons through the public funds expenditure on access. If the water resource user has to pay the full cost of his using that resource, he may find his preferences changing away from that use.

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
4a	Bighorn River, Yellowtail Dam to St. Xavier	Big Horn, Montana	3	3 to 1	15	(1) Access (2) Lack of spawning Area (3) Siltation (4) Goldeye	(1) Roads, parking, sanitary facilities on both sides of river at 2-mile intervals (5 acres each) (3) Stop silt in Beauvais, Soap, & Rottengrass Creeks	75 0	0 0		35,000
b	Bighorn River, St. Xavier to Hardin, Montana	Big Horn, Montana	3	3 to 2	25	(1) Access (2) Lack of spawning Area (3) Siltation (4) Gold eye	(1) Roads, parking, sanitary facilities on both sides of river at 2-mile intervals (5 acres each) (2) Intensive stocking (4) Goldeye barrier	125	0		33,000
8	Lakes & Streams on Beartooth Plateau	Carbon, Park, Stillwater, Sweetgrass, Montana				(1) Lack of information resulting in unused resources (2) Lack access (3) Empty habitats (4) Stunted fish populations (5) Winter kill	(1) Roads, trails, campgrounds, signs (2) Maps, Information & access acquisition	0			
10d	Rock Creek, Bluewater Creek, Red Lodge Creek,	Carbon, Montana	4 4 4	4 to 3 4 to 3 4 to 3	20 5 10	(1) Dewatering (2) Sediment (3) Channel Disturbence (4) Access	(1) Supplement or restore more desirable flows below many diversions during irrigation season (2) Better water use, streambank, fencing, etc. (3) Return to channel, revegetation & protect bank vegetation	0	60 cfs 60 cfs 60 cfs	not consumed	10,000

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED (Cont'd)

WIND-BIGHORN-CLARKS FORK RIVER BASIN

(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
f	Lodgegrass Creek	Bighorn,	3	None	5	(1) Dewatering (2) Sediment (3) Access	(1) Supplement or restore more desirable flows below many diversions during irrigation season (2) Clean up return flows, streambank fence, better grazing, etc.	0	16 cfs	not consumed	9,900
	Rottengrass Creek	Bighorn,	0	0 to 3	5			0	16 cfs		
	Sage Creek	Bighorn,	0	0 to 3	8			0	16 cfs		
	Willow Creek	Carbon,	4	None	5			0	16 cfs		
	Dry Creek	Carbon, Montana	0	0 to 3	4			0	16 cfs		
g	Pryor Creek	Carbon, Montana	4	4 to 3	15	(1) Dewatering (2) Sediment (3) Access	(1) Supplement or restore flows below irrigation diversions (2) Clean up return flows, streambank fence, better grazing, etc.	0	135 cfs (not consumed)		3,750
h	Clark's Fork River	Carbon, Montana	4	4 to 3	30	(1) Dewatering (2) Sediment, Oil and other pollution	(1) Supplement flows below irrigation diversions (2) Clean up return flows, streambank fences, better grazing, etc.	0	333 cfs (not consumed)		6,750
14	Bighorn (Yellowtail) Reservoir	Montana - Wyoming		None	12,685	(1) Legislative & administrative restrictions, marketing, distribution, and technological difficulties (2) Fish eggs destroyed by drying	(1) Commercial fishing for food and manufactured fish products and to enhance management of sport fishing resources (2) Spring drawdown before May 1 and stable or rising till June 1	0	0		(1) 60,000 lb. per year (2) 60,000 lb. f-men day

TABLE VII-4--STREAMS, LAKES, AND IMPOUNDMENTS WITH OPPORTUNITIES FOR FISHERY IMPROVEMENT--LAND AND WATER REQUIRED AND BENEFITS ESTIMATED (Cont'd)
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Fishery Opportunity No.	Subarea Stream of Impoundment	Location State or County	Present Fishery Class	Class Change	Acres or Miles	Limiting Factors	Needs (Improvement Opportunities)	Resources Needed: Land	Resources Needed: Water	Annual Fisherman-Day Benefits: Use	Annual Fisherman-Day Benefits: Capacity
15	Small Mountain Streams Beartooth Mountains	Carbon, Stillwater, Sweetgrass, Montana		0 to 4		(1) Dewatering (2) Sediment (3) Access	(1) Provide sustained flows (2) Clean up returned flows, streambank fence, better grazing, etc.	100	? (not consumed)		(1) Natural survival (2) Re-production naturally

Source: Montana Fish and Game Department

Potentials for fish and wildlife developments are largely limited to associated developments of water and land for other purposes. There is a good potential for wildlife habitat preservation and development and it should ben encouraged as part of the overall land treatment programs.

WATER QUALITY

Water quality as affected by human activity is not yet a serious problem in the Montana part of the Basin. There is some increase in temperature of return flows from irrigation that is not expected to change much except as sprinkler irrigation increases and total return flows increase. Sediment and nutrient content of return flows are not overly serious at present. Future problems may exist in pollution from feedlots and encroachment by summer home development on mountain stream flood plains. Strict enforcement of state laws and regulations might prevent this problem from becoming more serious as livestock feeding and population pressures increase. Although sediment is considered a serious problem on the Clarks Fork River, that part of the total sediment load originating from geologic erosion is so great that sediment from return irrigation flows is relatively insignificant. Elimination of man-caused sediment will have little effect on the overall sediment load of the river. However, there is a good potential for reducing erosion and sediment transport in irrigation wasteways and other selected sites.

MUNICIPAL WASTES

Municipal and industrial waste disposal for the Basin is summarized in table VII-5. Population and waste projections for communities are included in the FmHA county reports within the Basin.

Community sewer system improvements or new community sewer systems are needed in Hardin, Lodge Grass, Crow Agency, Red Lodge, Joliet, Belfry, Absarokee, and Fishtail to provide an opportunity for improving the water quality of streams near those communities. A community sewer system is considered necessary and feasible at Pryor and Silesia. A community sewer system is feasible in Rockvale, Bearcreek, and Boyd. The present subsurface systems are adequate unless problems develop in Grizzly Peak Mountain Homes Subdivision of Carbon County, East Rosebud Lake Association Development of Carbon County, Pompeys Pillar, and Huntley.

Waste discharge permits are issued to the communities having surface water discharges. Infiltration water, lack of secondary treatment, storm water entering sewage systems, operation problems, overloading, overflow and seepage, and possible health hazards created by individual subsurface systems are identified as problems of the existing sewage treatment systems.

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

Municipality or Industry	Estimated Load (p.e.) Untreated	Estimated Load (p.e.) Treated	Estimated Flow Discharged Million Gallons per Day	Status
STILLWATER RIVER				
Community of Absarokee	600	200	0.3	Considerable groundwater enters sewerage system which affects treatment in sewage lagoons. Need sealing of sewers to eliminate infiltration water.
CLARKS FORK RIVER				
Community of Belfry	200	0	0	Sewage lagoon system has no overflow.
Town of Bridger	700	100	0.2	Sewage lagoon system to be tested for adequacy by Dept. of Health during coming year.
Town of Fromberg	350	60	0.03	An additional lagoon cell is being planned to provide improved treatment.
Community of Edgar	200	0	0	No overflow from sewage lagoon system.
ROCK CREEK				
City of Red Lodge	1,800	0	0	No overflow from new sewage lagoon system. Considerable infiltration in sewer system

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Continued)

Municipality or Industry	Estimated Load (p.e.) Untreated	Estimated Load (p.e.) Treated	Estimated Flow Discharged Million Gallons per Day	Status
City of Red Lodge (Continued)				and survey needs to be made to determine construction work needed to eliminate excess water. Heavy loading placed on treatment system by cannery.
Community of Roberts	200	50	0.1	Considerable infiltration of groundwater occurs in sewerage system. Sealing of sewers or additional lagoons are needed.
Town of Joliet	400	100	0.1	Considerable groundwater enters sewerage system. Improvements have been recently made to existing primary treatment facilities to upgrade treatment. Dept. of Health to test treated discharge during coming year to determine adequacy of treatment.
YELLOWSTONE RIVER				
Communities of Worden and Ballantine	600	0	0.0	Lagoon system presently does not have overflow.
Community of Custer	200	0	0.0	Lagoon system presently does not have overflow.
BIGHORN RIVER				
Yellowtail Dam Visitor Center	30	5	0.003	Activated sludge secondary treatment facilities treat wastewater.

TABLE VII-5--STATUS OF MUNICIPAL AND INDUSTRIAL POLLUTION OF RIVERS (Cont'd)

Municipality or Industry	Estimated Load (p.e.) Untreated	Estimated Load (p.e.) Treated	Estimated Flow Discharged Million Gallons per Day	Status
BIGHORN RIVER (Continued)				
Ft. Smith Federal	300	30	0.01	Sewage lagoons serve as treatment facility.
City of Hardin	3,000	600	0.1	Sewage lagoon improvements are planned when grant funds become available.
LITTLE BIGHORN RIVER				
Town of Lodge Grass	600	200	0.03	Lagoon improvements are planned by the U. S. Public Health Service
Community of Crow Agency	2,000	0	0.0	Lagoon system presently overloaded. Treatment system preceding lagoons planned for 1973. Major contribution of wastewater by carpet mill.

Source: Montana Department of Health and Environmental Sciences

OTHER URBAN WASTES

These wastes primarily include runoff from developed areas, storm water, and drainage from solid waste disposal sites. These problems are noted under remarks in table VII-5.

INDUSTRIAL WASTES

The major industries in this Basin are primarily related to agriculture, petroleum, mining, and forest products. Other types of industry exist, but generally they have less impact on the Basin water quality. Industries which discharge waste waters to surface streams are required to have a waste discharge permit.

MINING ACTIVITY

Increasing demands for power and the development of extra-high voltage power transmission enhances the potential economic feasibility of mine-mouth thermal-electric power generation from eastern Montana coal fields. Nearly 1.5 million acre-feet of water per year will be required by the coal industry according to studies made on coal development potentials east of this Basin by the Bureau of Reclamation. The Montana Department of Natural Resources and Conservation has been instructed by the 41st Legislative Assembly by Legislative Joint Resolution #18 to keep the Legislative Council informed of progress on the development of Montana's coal resources and of any agreements contemplated which might affect water to be used from the drainage areas of the Bighorn and Little Bighorn Rivers.

AGRICULTURAL WASTES

The most common water quality degrading characteristics of irrigation return flows are total dissolved solids, sediment, and chemicals. The main factors influencing the impact of irrigation return flow on water quality are soils and geology, type of irrigation used, and farming practices (use of chemicals, etc.). There is a potential for improving water quality and protecting the environment through education and land treatment measures to reduce agricultural pollution of streams.

FEEDLOT WASTES

Cattle feeding within the Basin can be expected to increase substantially in the future. Currently, the larger feedlots in the Basin are located in Yellowstone County.

With all new feedlots, proper location and waste treatment facilities can be expected so little additional waste contribution to streams is anticipated from these sources. The actual effects upon streams from existing feedlots within the Basin have not been determined, but are

believed to be minor. The Montana Department of Health and Environmental Sciences has held hearings on a feedlot waste discharge permit regulation and a regulation was adopted on June 24, 1972. However, there is potential for protecting the environment through education and enforcement of health regulations.

RECREATIONAL WASTES

Outdoor recreation will continue to be an important factor in future development of this Basin. Wastes from recreation may be minor in volume, but costly to control because of dispersion over large areas. Again the potential for environmental protection lies in education and enforcement of regulations.

LAND TREATMENT

The updated Conservation Needs Inventory points up the large amount of land treatment that is still needed. There is a potential for much of this treatment on irrigated land to improve irrigation efficiency and on rangeland to improve grazing distribution and prevent erosion.

The greatest potential for beneficial land treatment on cropland consists of improving irrigation management and irrigation systems on about 130,000 acres and on-farm drainage on about 50,000 acres. The greatest potential on rangeland consists of rangeland protection on about 1,560,000 acres and brush management and range improvement on about 500,000 acres. The large potential for land treatment indicates a need for accelerated investment in this area and continuing activity over time.

Land treatment needs on forested lands are related to: (1) correction of previous poor management practices such as overgrazing, poor road location, abandoned roads and trails and mineral exploration disturbances; and (2) control of existing or potential problems such as control of mineral exploration practices, off-road vehicular travel and recreation overuse. While continued enforcement of existing laws and better land management planning will greatly reduce future problems, there is a potential for correcting past problems through structural measures such as streambank stabilization, installation of physical erosion control structures on abandoned roads and trails, rehabilitation of old mining disturbances, or vegetative measures such as reforestation of denuded forest lands and reseeding of overgrazed and eroding rangelands. Due to the dramatic climatic conditions in the high mountainous areas and the semiarid regions, it is not practical from a watershed management viewpoint to wait until nature heals wounds such as abandoned roads which generally continue to erode. There is a potential for development of structural land treatment measures along with improved management techniques.

POTENTIAL FOREST INDUSTRY DEVELOPMENT

The characteristics of the Basin forest industry discussed in chapter three indicate that no significant increase in this activity may be expected. In fact, the probable level of development will decline.

NATURAL BEAUTY

There is a real opportunity to develop positive programs to protect the visual resource through repair or altering past scars. It is no longer practical or sound to plan for development potential without providing for esthetics of these projects. The potential lies in designing water and land resource projects to fit the landscape of which they become a part. Projects need to be designed to meet people's needs, including visual quality.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACT OF USDA PROGRAMS

The U. S. Department of Agriculture and agencies of the State of Montana participated in this river basin study to identify opportunities to solve water and related land resource problems and improve the economic situation of the area. Through the identification of these opportunities and the realization of their interrelationships in water use and impacts, it is hoped that a coordinated, priority-oriented development can be accomplished.

PUBLIC LAW 566

All of the 44 hydrologic watersheds or parts of watersheds in Montana's share of the Basin were investigated as to their potential for PL-566 project development. During the early process of investigation, 20 watersheds were found to have no project potential in that they had insufficient flooding damages, irrigation shortages, or drainage needs to warrant project action. The remaining 24 watersheds under more intensive study were found to have nine potential feasible projects; 12 economically infeasible, but physically potential projects; and three questionably feasible projects. The nine potential projects and two questionable projects are described below. (See map VIII-1.)

14-32 Fly Creek

In the Fly Creek fan area of the Huntley Irrigation Project, there is a project opportunity to provide drainage outlets to the Yellowstone River. About 11,500 acres are now damaged by high water table caused by irrigation development without sufficient drainage. It is estimated that 130 farms can be made more productive. Along with the drainage outlets, 20,000 acres need land treatment in the form of field drainage, water control structures, and improved irrigation management.

14-27 Blue Creek

The drainage of Blue Creek, across the Yellowstone River from Billings, is being built up very rapidly with rural residences. At present there are 25 homes and a grade school that have been damaged by summer floods. Seven years ago there were only nine homes on the flood plain. Nearly all the flood plain is platted subdivision. Without flood prevention measures, it appears that a tragedy is in the making. There is a good dam site that will control 60 percent of the drainage area and could provide an excellent recreational pool and municipal and fire protection water for the many new homes in the area.

14d-1 and 14d-2 Pryor Creek

Pryor Creek has an excellent multipurpose development potential that can be of high economic development benefit to Indian Trust lands. About 55 percent of the land in the two watersheds is Indian Trust land. The watershed provides ample water yield to develop all the high quality

irrigable bottom lands of the Pryor Creek valley. A dam site has been identified on the main stem of Pryor Creek just below where the East Fork of Pryor Creek joins the main stem. At this location, about 25 miles from Billings, the recreational pool would receive a lot of use. Below the reservoir, 1,607 acres now irrigated would receive supplemental water and 2,632 acres now in dryland and pasture would receive a full supply of irrigation water. This new irrigation would logically shift into production of corn and corn silage because it is the closest haul (10-20 miles) to one of Montana's largest new feedlots. Migratory waterfowl would benefit from the resting area near large wheat fields.

14c-9 Red Lodge-Rock Creek

This watershed needs improvement in irrigation efficiency and cooperation in exchange of stored water for direct diversion water. Some ditch consolidation may be warranted. Some increase in import of water from East Rosebud Creek may be desirable. Water use and diversion measurements are inadequate to base plan formulation. A history of unused storage capacity in Cooney Reservoir indicates an unwillingness of irrigators in the upper watershed to pay one dollar per acre-foot for irrigation water. Feasibility of further project action is very questionable under such circumstances.

14c-10 Elbow Creek

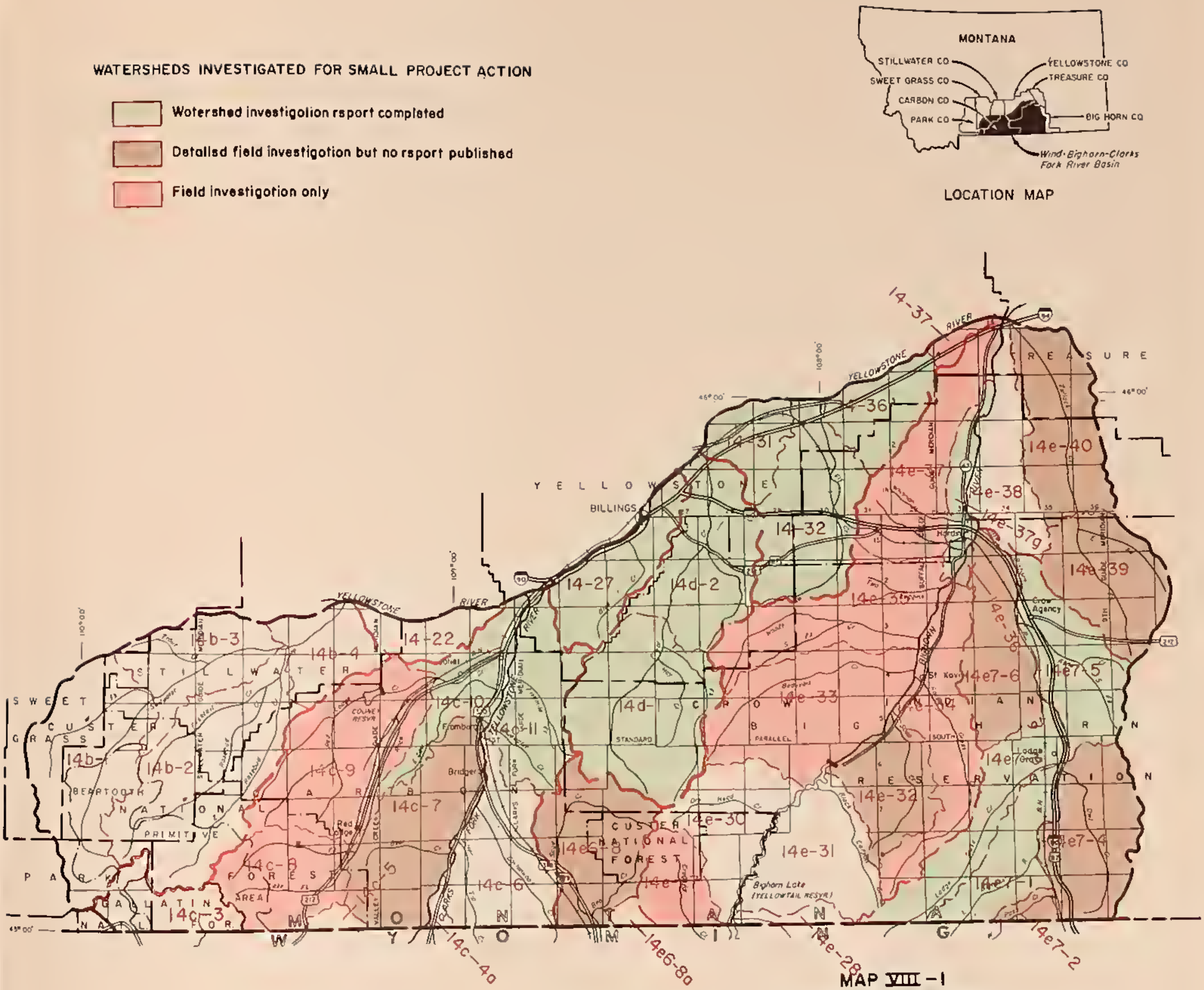
This watershed would provide offstream storage for supplemental water and conversion of some additional dryland to irrigation. Water-based recreation would help alleviate heavy weekend pressure on Cooney Reservoir. About 5,300 acres now irrigated would be assured of a supplemental supply and 1,400 acres now in dryland would be provided a full supply of water. An existing canal would be enlarged and extended to bring unused off-season water to the Elbow Creek reservoir site.

14c-11 Lower Clarks Fork East Side

Lands now irrigated in this watershed are short of water during the peak irrigation demand period, thus limiting their production. Bluewater Creek has about 5,000 acre-feet of unused off-season water that could be stored and released into the Orchard and Edgar Canals to provide that full season use. Recreational and fish and wildlife water can provide additional benefits during summer months.

14e-37a Two Leggins Irrigation Unit

This watershed is badly in need of a coordinated reorganization, canal consolidation, and drainage project to alleviate high water table conditions on potentially good irrigated lands. These changes are needed to improve the economic efficiencies of agriculture in a disadvantaged area. Over half the county is in the Crow Indian Reservation,



MAP VIII-1
WATERSHEDS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
MONTANA
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

APRIL 1973

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22914P

and the sugar factory in Hardin has gone out of business. It is estimated that the project would benefit 14,000 acres now damaged by high water tables and improve the economy on 70 farms. An application for Public Law 566 assistance has been filed, but authority for planning has not yet been granted.

14e-39 and 14e-40 Tullock Creek

Tullock Creek has many acres of bottom lands that get mainly waterspreading irrigation during flood periods. Much of the spring runoff goes down the creek with little use. By storing runoff for more timely use to supplement the present irrigation, yields can be improved to augment the forage base and alleviate the pressure on range lands. Only incidental recreational and fish and wildlife benefits would be realized.

14e7-1 Upper Little Bighorn River

There is an opportunity to develop a new diversion just below Wyola to carry presently unused streamflow to about 2,900 acres of good dryland on the Crow Indian Reservation. The proposal would help 20 farms and provide an increase in employment opportunities in irrigation, harvest, and feeding of hay and corn silage. The proposal is both engineeringly and economically feasible.

14e7-3 Lodge Grass Creek

Lodge Grass Creek has a history of flooding the town of Lodge Grass and interrupting traffic on U. S. Highway 87. The damages can be prevented with a combination of upstream diversion into Lodge Grass Reservoir, flood storage on Good Luck Creek drainage, and a flood training dike around the town of Lodge Grass to handle flows from the uncontrolled area. Only incidental recreational benefits are expected from the storage site on Good Luck Creek.

14e7-5 Little Bighorn East Side

There is an opportunity to develop two small pump-lift irrigation units in this watershed. In one unit, the water would be lifted 55 feet to a canal to irrigate 1,100 acres about eight miles south of Crow Agency. In the other unit, water would be lifted 65 feet to canals to irrigate 1,170 acres just three miles south of the confluence of the Little Bighorn and Bighorn Rivers. Both units are on the Reservation. Ample unused water is available for this development.

The overall environmental impact of potential PL-566 projects and land treatment under various USDA programs would be definitely beneficial. Probably the greatest impact would consist of reduction of erosion and sediment production. Next would be a substantial increase in resting and nesting area for waterfowl and water supplies for big game and upland game birds in farm ponds and multipurpose watershed reservoirs. Breaking

up of single-type habitat by irrigation development would provide edge and fringe habitat and water supplies not now available for wildlife. In potential projects, an increase of about ten miles of live streamflow can replace intermittent flow. Also, loss of about two miles of low value live streamflow and 40 acres of streambank habitat would be offset by 1,000 new acres of recreational water surface and its related shoreline. These same projects would trap about 61 acre-feet of sediment per year that are presently polluting streams and rivers. A summary of PL-566 projects and their impacts is shown in table VIII-1.

ECONOMIC IMPACT

Installation of works of improvement can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate task, if not impossible, to quantify all effects likely to occur. The Basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) the basic group which includes agriculture, forestry, manufacturing and mining which produce goods and services locally for consumption mainly outside the Basin; and (2) the derivative or service-oriented group which includes those industries whose goods and services are mainly consumed locally. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a sort of chain reaction in motion that is reflected through all sectors of the economy.

A ratio of basic activity to derivative activity is computed from employment data as reported in U. S. Census of Population. This ratio is not static. The number of employees in the derivative group becomes larger relative to the basic group over long periods of time. Employment data from tables III-6 and III-9 are combined to show the following:

	Employment			
Year	Total	Basic	Derivative	B/D Ratio
1940	8,512	5,476	3,036	1: .55
1950	8,610	4,798	3,812	1: .79
1960	7,847	3,465	4,382	1:1.26
1970	7,085	2,572	4,513	1:1.75
1980	6,700	2,150	4,550	1:2.12
2000	6,400	1,800	4,600	1:2.55
2020	6,300	1,700	4,600	1:2.70

TABLE VIII-1--SUMMARY OF WATERSHED INVESTIGATION REPORTS AND THEIR IMPACTS

WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

WATERSHED NAME AND NUMBER	Potential State of Montana Involvement	Installation Cost ($)	Annual Cost (5-5/8%) ($)	PHYSICAL & BIOLOGICAL IMPACTS (Annual Amount of Change): Net Water Consumption (A.F./yr.)	Water Supply Timing Change (A.F./yr.)	Water Quality (T.D.S.-PPM)	Sediment Reduction (A.F. or tons/yr.)	Fish & Wildlife Habitat (Acres or Miles of Stream)	Vegetative Improvement (Acres)	Erosion Reduction (Acres)
EARLY ACTION:										
1. Blue Creek, 14-27	Rec. Co-sponsor	3,183,810	206,590	420	2,460	--	9.53 AF/yr	+5 miles	--	--
2. Pryor Creek, 14d-1, 14d-2	Irr. & Rec. Co-sponsor	2,797,300	188,980	6,265	9,902	--	28 AF/yr	+2 miles	4,207	--
3. Two Leggins Irr. Unit, 14r-37a	---	5,147,370	342,100	--	--	--	--	nil	8,900	--
4. Upper Little Bighorn River, 14e7-1	Irr. Co-sponsor	436,520	26,850	5,800	--	--	--	+	2,900	--
5. Lodge Grass Creek, 14e7-3	---	580,630	34,900	--	--	--	5.4 AF/yr	-6 acres	--	--
LATER ACTION: 1/										
1. Huntley Irrigation Project, 14-31, 14-32, 14-36	Drainage Co-sponsors	1,952,600	125,320	--	--	--	--	nil	11,700	--
2. Elbow Creek, 14r-10	Irr. & Rec. Co-sponsors	1,790,600	117,510	5,550	10,450	--	7 AF/yr	-35 acres	1,400	40
3. Bluewater Creek, 14r-11	Irr. & Rec. Co-sponsors	1,900,280	127,050	2,600	5,698	--	11 AF/yr	+5 miles	5,354	--
4. Little Bighorn East Side, 14e2-5	---	355,730	27,520	4,540	--	--	--	--	2,270	--

WATERSHED NAME AND NUMBER	ECONOMIC IMPACTS (Annual Benefits): Flood Damage Reduction ($)	Increased Agricult. Production ($)	Increased Per Capita Income ($)	Increased Employment (Man-Yrs)	Total Secondary Benefits ($)	Increased Recreational Use (Visitor-Days)	New Community Water Supplies (Number Persons Served)
EARLY ACTION:							
1. Blue Creek, 14-27	102,900	--	--	--	--	17,610	400
2. Pryor Creek, 14d-1, 14d-2	7,500	474,000	NA	27	79,250	57,275	--
3. Two Leggins Irr. Unit, 14r-37a	--	974,000	7,000/45	24	162,770	--	--
4. Upper Little Bighorn River, 14e7-1	--	273,000	4,000/14	9	46,900	--	--
5. Lodge Grass Creek, 14e7-3	36,000	--	--	--	--	1,375	--
LATER ACTION: 1/							
1. Huntley Irrigation Project, 14-31, 14-32, 14-36	--	904,440	5,000/55	15	151,000	--	--
2. Elbow Creek, 14r-10	--	218,817	6,000/21	9	19,000	41,135	--
3. Bluewater Creek, 14r-11	--	246,000	4,500/26	5	37,500	46,720	--
4. Little Bighorn East Side, 14e2-5	--	238,000	4,800/11	8	40,400	--	--

WATERSHED NAME AND NUMBER	LAND USE AND AVAILABILITY CHANGE: Cropland to Grassland (Acres)	Cropland to Wildlife & Recreation (Acres)	Range to Cropland (Acres)	Wetland to Cropland (Ac)	Range to Recreation (Acres)	Land to Water Surface (Ac. Ac)	SOCIAL IMPACTS: Cropland With Improved Production (Ac.)	Grassland With Improved Production (Acres)
EARLY ACTION:								
1. Blue Creek, 14-27	--	--	--	--	120	168	--	--
2. Pryor Creek, 14d-1, 14d-2	--	200	2,285	--	800	315	1,922	2,285
3. Two Leggins Irr. Unit, 14r-37a	--	--	--	8,900	--	--	8,900	--
4. Upper Little Bighorn River, 14e7-1	--	--	--	--	--	--	2,900	--
5. Lodge Grass Creek, 14e7-3	--	--	--	--	27	27	--	--
LATER ACTION: 1/								
1. Huntley Irrigation Project, 14-31, 14-32, 14-36	--	--	--	11,700	--	--	11,700	--
2. Elbow Creek, 14r-10	--	--	500	--	400	215	6,182	500
3. Bluewater Creek, 14r-11	--	--	--	--	--	235	5,354	--
4. Little Bighorn East Side, 14e2-5	--	--	1,135	--	--	--	1,135	1,135

Source: River Basin Planning Staff

1/ Some of these projects may move into Early Action category.

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 37,000 acres in the watersheds investigated will be affected. Changes in land use are expected on only part of the total; however, nearly all the benefited area will be used more intensively and efficiently. Hay, silage, and feed grain production will be increased while sugar beet, pasture, and range production will decline.

By 2000, with the resource developments in place and operative, the gross value of agricultural production will be increased $3,328,000. Approximately 68 percent of the increase ($2,269,000) will come from lands that are irrigated at the present time and need either additional water or the removal of excess water. Supplemental irrigation water will be provided by the projects. The remaining 32 percent ($1,059,000) will come from land that is currently used for grazing and dryland crops, but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the Basin and will contribute to economic development objectives. To the extent that additional agricultural production and associated economic activity merely displace production and activity in other areas or affect market prices, the benefits may not truly be national gains. Therefore, it is assumed that output-increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of agricultural production per agricultural employee in 2000 is estimated at $43,380.1/ If it is assumed that agricultural labor resources are fully employed without the plan, that additional output will provide for 97 additional basic employees. By applying the employment multiplier for the year 2000, it can be shown that derivative employment can increase by 247. The total impact on employment resulting from the increased agricultural production associated with the programs is estimated to be as much as 344. This is comparable to providing employment for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $620 of net farm income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $1.4 million) can be considered as income to the Basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the Basin, and in turn, respent within the area until its

1/ Gross value of agricultural production from table III-13 ($52,056,000) divided by the number of agricultural employees from table III-9 (1,200).

marginal effects become zero. A summation of these successive rounds of spending is commonly called the income multiplier. This indicator measures the total change in a particular sector. Recent studies in areas similar to the Basin estimate the income multiplier to be about 2.0. If the entire $1.4 million were dispersed in the Basin, the total income effect would be at least $2.7 million annually, which is an average of $123 per resident. No attempt was made to project the income multiplier for 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of installation costs and part of the other costs for watersheds investigated in this study total $9,658,500. If a fifteen-year period is required for project installation and federal funds are provided in equal increments over the period, this is equivalent to $643,000 annually. All of this investment can represent new income to the study area provided a local contractor is employed and he purchases capital, labor, supplies, and machinery within the study area. The local area could be enriched as much as $1,286,000 annually because the added increment of new investment income during the fifteen-year construction period is affected by the income multiplier.

LAND TREATMENT

With accelerated improved rangeland management, the Basin's ranching economy can be increased on private and state land by nearly one million dollars annually. Projections show a potential increase by year 2000 of about 172,500 animal unit months of grazing and $862,500 of annual increased income resulting from proposed range condition improvement.

In addition to, and in line with the Montana Rangeland Resource Plan, ranchers have an opportunity to supplement their regular incomes by taking advantage of additional recreational enterprise opportunities. These enterprises, plus the necessary supporting businesses, would add materially to the annual income of the area. Other benefits will be in the form of money saved from reducing pollution and erosion from rangeland after range condition improvements.

By 2000, accelerated land treatment on cropland will have the potential to increase feed output by the equivalent of about 267,400 animal unit months per year worth about $1,334,000. Potential to increase forage on private and state forested land will amount to about 7,700 AUM's worth $38,500 per year. See table VIII-2.

TABLE VIII-2--PROJECTED CHANGES IN AUM FORAGE EQUIVALENTS OF PRODUCTION BY LAND TREATMENT ALTERNATIVES ON STATE AND PRIVATE LANDS
Wind-Bighorn-Clarks Fork River Basin
(Montana)

Treatment Practice	Area Needing Land Treatment	PROJECTED EXISTING PROGRAMS: Applied by Year 2000	PROJECTED EXISTING PROGRAMS: Installed Cost	PROJECTED EXISTING PROGRAMS: Annual Forage Equivalent Increase 1/	PROPOSED ACCELERATED PROGRAMS: Applied by Year 2000	PROPOSED ACCELERATED PROGRAMS: Installed Cost	PROPOSED ACCELERATED PROGRAMS: Annual Forage Equivalent Increase 1/
	(Acres)	(Acres)	(Dollars)	(AUM's)	(Acres)	(Dollars)	(AUM's)
Irrigated Cropland							
Cultural or Management Measures	23,933	7,600		1,900	16,800		4,200
Improved Irrigation Systems	132,180	27,800		79,200	62,000		176,700
Water Management Only	14,614	3,800		6,600	8,400		14,700
On-farm Drainage Only	50,000	8,000		32,000	17,800		71,200
Subtotal	220,727	47,200	15,100,000	119,700	105,000	33,600,000	266,800
Nonirrigated Cropland							
Cultural or Management Measures	206,180	33,900	1,425,000	300	68,400	2,875,000	600
Pasture and Rangeland							
Needs Protection Only	1,558,602	488,500		48,800	1,252,800		125,300
Needs Improvement Only	79,226	24,800		2,500	63,700		6,400
Brush Control & Improvement	417,805	81,800		12,300	209,900		31,500
Reestablish Vegetative Cover	22,533	7,100		3,600	18,100		9,100
Reestablishment & Brush Control	1,085	200		100	500		200
Subtotal	2,079,251	602,400	3,000,000	67,300	1,545,000	7,725,000	172,500
Forested Land							
Management to Improve Forage	113,370	56,700		5,700	90,700		9,100
Reduction of Grazing	39,300	7,900		-800	13,800		-1,400
Subtotal	152,670	64,600	450,000	4,900	104,500	725,000	7,700
Other Lands							
Vegetative & Structural Measures	22,548	8,200	1,800,000	NA	18,500	4,075,000	NA
TOTALS	2,681,376	756,300	21,775,000	192,200	1,841,400	49,000,000	447,600

Price base 1974. NA = Not applicable

1/ All crop and forage production converted to AUM's of forage equivalents (i.e., 450# corn or 900# hay equals 1 AUM.)

SELECTED FORESTED LAND TREATMENT OPPORTUNITIES

This section of the report relates to forest land treatment needs on 11 potential watersheds within the Wind-Bighorn-Clarks Fork Type 4 River Basin study. The inventory was based on a field, map, and aerial photo reconnaissance survey of the following watersheds:

Watershed Name	Watershed Number	Forest Acres
Upper Little Bighorn River	14e7-1	11,520
Lodge Grass Creek	14e7-3	17,280
Little Bighorn - East Side	14e7-5	6,080
Two Leggins Irrigation Unit	14e-37a	1,100
Tullock Creek - Upper & Lower	14e-39 & 40	20,116
Fly Creek	14-32	26,230
Blue Duck Creek	14-27	250
Pryor Creek - Upper & Lower	14d-1 & 2	35,350
Red Lodge - Rock Creek	14c-9	16,570
Elbow - Lower Rock Creek	14c-10	3,720
Lower Clarks Fork - East Side	14c-11	3,842
	TOTAL	142,108

Nine major categories of forest land treatment opportunities were identified during the survey and briefly described. (See table VIII-3.)

In addition to the 11 watersheds that were investigated, there are 18 other watersheds that contain forested lands. There is only limited information available on these forested lands, most of which are privately owned. General information indicates that land treatment measures on these watersheds will be similar to those displayed in table VIII-3. Additional field investigations are needed to accurately assess the opportunities on these areas.

Stream Channel Clearing

This work consists of removing log debris (primarily cottonwood) from major stream and river channels which are deflecting peak runoff flows toward banks causing scouring, sedimentation, and reduction of channel capacity and water quality.

TABLE VIII-3--SELECTED FORESTED LAND TREATMENT NEEDS FOR WATERSHED INVESTIGATION REPORTS
WIND-BIGHORN-CLARKS FORK RIVER BASIN
(Montana)

							SUPPLEMENTAL LAND TREATMENT NEEDS						
Watershed Name	Watershed Number	Gross Acres	Forested Acres	% Forested Land	River Miles Primary Channel	Stream Channel Log Debris Clearing (Miles)	Streambank Stabilization (Miles)	Sheet Erosion Control (Acres)	Gully Stabilization (Acres)	Road & Trail Stabilization (Acres)	Afforestation & Reforestation (Acres)	Forest Mgt. Plans (Acres)	Forest Fire Protection (Acres)
Upper Little Bighorn River	14e7-1	88,346	11,520	13.0	32	4.5	2.4	300	57	75	575	11,520	11,520
Lodge Grass Cr.	14e7-3	108,938	17,280	15.8	32	5.0	3.5	400	86	96	860	17,280	17,280
Little Bighorn-East Side	14e7-5	141,321	6,080	4.3	32	4.0	2.2	100	30	48	300	6,080	6,080
Two Leggins Irrigation Unit	14e-37a	32,781	1,100	3.3	16	3.0	1.0	25	5	8	55	1,100	1,100
Tullock Cr. - Upper & Lower	14e-39 & 40	298,119	20,116	6.7	64	7.0	3.0	400	100	80	1,005	20,116	20,116
Fly Creek	14-32	179,151	26,230	14.6	32	2.0	2.4	500	131	109	1,010	26,230	26,230
Blue Duck Cr.	14-27	118,570	250	.2	16	1.0	.5	5	1	2	10	250	250
Pryor Cr. - Upper & Lower	14d-1 & 2	389,422	35,350	9.0	96	8.0	7.2	600	176	180	1,400	35,350	35,350
Red Lodge-Rock Cr.	14c-9	207,780	16,570	7.9	80	11.0	4.5	300	82	132	800	16,570	16,570
Elbow-Lower Rock Cr.	14c-10	91,302	3,770	4.2	32	3.5	6.5	75	18	30	180	3,770	3,770
Lower Clarks Fork-East Side	14c-11	133,184	3,842	2.8	40	2.0	4.0	80	19	30	192	3,842	3,842
TOTAL UNITS		1,788,914	142,108	7.9	472	51	37.2	2,785	705	790	6,387	142,108	142,108

Source: River Basin Planning Staff

Streambank Stabilization

Work involves riprap of channel bank meanders which are scoured and contain fine-textured, eroding soils. Work consists of rock placement, dozer shaping, and revegetation to grass, brush, or trees.

Sheet Erosion Control

Work involves revegetation and fertilization of scattered areas throughout the subwatersheds. In some areas, grading of rilled areas will be required to prepare a stable angle of repose for revegetation.

Gully Stabilization

Work consists of plugging, reshaping, and revegetating major gully formations in fine-textured eroding soils which are actively contributing sediment to streams during peak runoff.

Road and Trail Stabilization

Work involves drainage, revegetation, and abandonment, where practicable, of work access roads and trails in the subwatersheds. In some areas, improved stream crossings are needed such as log bridges, culverts, or hardstanding fords.

Afforestation and Reforestation

Many forest acres require planting to reach full stocking, and, conversely, a few overstocked stands need thinning. Also, some areas of steep, eroding slopes should be converted from range to forest for maximum production.

Forest Management Plans

To insure sound investments, specific forest land treatment needs should comply with objectives jointly agreed to in a forest management plan. For example, there is little value in reforestation if cattle graze uncontrolled.

Forest Fire Protection

Adequate wildfire protection must be assured to protect any land treatment investment. In most cases, these funds could best be used to upgrade local fire department equipment and training.

Technical Support Overhead

This work involves the preparation of detailed project plans, once land treatment funds are available, and provision for the necessary technical supervision during the life of the project installation.

Cost Basis

The following 1972 base unit cost for the major forest land treatment measures were used in the analysis which totals $992,018 for treatment of 142,108 forest acres in the 11 project watersheds:

Treatment	Units	Cost/Unit
Stream channel debris clearing	Miles	$ 500.00
Streambank stabilization	Miles	1000.00
Sheet erosion control	Acres	100.00
Gully stabilization	Acres	200.00
Road and trail stabilization	Acres	100.00
Reforestation, afforestation, thinning	Acres	50.00
Forest management plans	Acres	.10
Forest fire protection	Acres	.05
Technical support overhead	Subwatersheds	10 percent of treatment cost

RESOURCE CONSERVATION AND DEVELOPMENT PROJECTS

Project proposals in the Beartooth RC&D area of the Basin include many opportunities that deal with water and land resources. Several proposals have been made on ditch consolidation and irrigation system reorganization. Many of these can be developed as small group projects and a few would qualify as watershed projects. One of the more serious proposals deals with renovation of the principal spillway of Cooney Reservoir, improving the recreational facilities, and developing a reservoir management plan based on snow surveys. Development of more fishing access along Rock Creek and the Stillwater River is requested. Streambank riprap to stop erosion in critical locations is proposed for Rock Creek, Stillwater River, and Clarks Fork River. Reduction of sediment in the Clarks Fork River is proposed as a potential for enhancing the fishery.

Several areas with high water tables are noted for group drainage. Gravel pits can be renovated into fishing ponds with camping facilities. Several locations were noted for their recreational development potential, including overnight camping, vacation camping, dude ranches, historical trails development, and national parkway development of the Red Lodge to Cooke City highway over Beartooth Pass.

Water and sewer improvements were suggested for Bearcreek, Belfry, and Bridger. Sanitary land fills were suggested for the northern part of Carbon County and Belfry as potentials for improving the environment. Nearly every community suggested school consolidation, including addition of vocational education. Most project proposals deal directly or indirectly with attempts to improve the economic and social well-being of the area.

IX. COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

The implementation of an orderly and comprehensive program for development of the Basin's water and related land resources should be based on coordinated proposals of federal, state, and local agencies which will be accepted by the people in the Basin. The Governor's Office of Budget and Program Planning serves as the clearinghouse for all planning and programs supported by federal funding. The Water Resources Division of the Montana Department of Natural Resources and Conservation has the responsibility to coordinate the various federal, state, and local water development projects and to formulate a comprehensive, coordinated multiple-use state water plan. Within this framework, many of the problems and opportunities identified in this report can be corrected and developed under various on-going programs of USDA and other agencies. Individual project planning will be required in most instances and those project plans need to be coordinated into the overall Basin development instead of using an independent project development approach.

Data compiled in this report will be useful in later planning efforts which may incorporate the new Principles and Standards for water and related land resource planning. Under those standards, public involvement and analysis of alternative plans for resource development are heavily stressed. Beneficial and adverse effects to all segments of society will be evaluated to determine the desirability of resource development proposals.

Under the Montana State Water Plan, the Water Resources Division of the Montana Department of Natural Resources and Conservation is responsible for public involvement and coordination of various agency projects and programs for water development. It is the policy of the Montana Water Plan to bring all interested parties into the planning process early enough for them to have an effect on the results of the study.

ALTERNATIVE APPROACHES

Opportunities for development identified in chapter VIII could be developed by means other than USDA programs. These alternatives include individual and group private development, state-planned or -subsidized projects, small irrigation projects under the Bureau of Reclamation or the Bureau of Indian Affairs, flood prevention under the Corps of Engineers, and flood plain control under the state and local government action. Alternatives for PL-566 project developments include the following:

Fly Creek Watershed drainage could be accomplished by private groups or under Bureau of Reclamation's small project program.

Blue Creek flood prevention could be provided through strict flood plain zoning and relocation of some existing homes.

Pryor Creek irrigation and recreation could be developed under small watershed programs of either Bureau of Reclamation or Bureau of Indian Affairs.

Red Lodge-Rock Creek water exchange and irrigation reorganization might be achieved through Water Use Act procedures under Montana Department of Natural Resources and Conservation.

Two Leggins irrigation and drainage could be improved under the small watershed program of the Bureau of Reclamation.

Tullock Creek irrigation storage might be built through Montana Department of Natural Resources and Conservation or Bureau of Reclamation programs.

Upper Little Bighorn diversion and irrigation could be installed by a private group or under leadership from the Bureau of Indian Affairs.

Lodge Grass flood prevention could be provided by local government or Corps of Engineers construction of a flood training dike.

Lower Little Bighorn pump-lift irrigation could be installed by private individuals or groups.

Conservation land treatment measures on private lands could be applied by landowners without federal technical or financial assistance.

PROJECTS OR MEASURES NEEDED BUT NOT PRESENTLY AVAILABLE THROUGH USDA PROGRAMS

It is difficult to determine what needs should be satisfied first in a Basin. In spite of this, there are some areas which are not covered adequately by USDA programs and which need help. These include: management of nonagricultural land use and land development, flood plain management, better measurement of water use, mineral-related water, fossil-fuel factors, environmental quality, and water rights related to the Yellowstone River Compact.

Bureau of Reclamation project proposals in Montana include the following:

The Hardin Unit would use Big Horn River water to irrigate about 47,500 acres now mostly in dryland crops and mostly within the Crow Indian Reservation.

The Little Bighorn and Dunmore Units would use Little Bighorn River water to irrigate about 18,200 acres--all within the Indian Reservation.

There are several other deferred Bureau project proposals in the Basin. Anyone desiring more detailed information should contact the Regional Director for the Bureau of Reclamation at Billings, Montana.

At present, the local share of the costs are borne by the project sponsors while the greatest share of the recreation and fish and wildlife benefits are enjoyed by people living outside the project area. More of these costs need to be borne by people receiving the benefits. Similar needs apply to water quality enhancement and environmental protection.

There is a need for greater funding of flood plain studies and financing nonstructural flood plain management measures as an alternative to structural control measures.

OTHER AGENCY PROGRAMS AND THEIR IMPACTS

When all interests are brought together in a coordinated water planning effort, in addition to USDA at least the following departments and agencies should be involved: U. S. Department of the Interior, U. S. Geological Survey, Bureau of Indian Affairs, Bureau of Sport Fisheries and Wildlife, Bureau of Land Management, Bureau of Reclamation, Bureau of Outdoor Recreation; Department of the Army, Corps of Engineers; Environmental Protection Agency; Missouri River Basin Commission; Old West Regional Commission; Montana Department of Natural Resources and Conservation; Montana Department of State Lands; Montana Department of Fish and Game; Montana Department of Health and Environmental Sciences; Montana Department of Intergovernmental Relations, Planning Division.

Any program for the public land which affects grazing use will affect agriculture in the Basin. A reduction in forage taken from public land would require either a reduction in animal units in the Basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland, but would probably encourage an increase of animal units in the Basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing lands. USDA agencies can, and should, be actively involved in the development and coordination of such programs.

Because the next planning effort in the Basin is expected to use some form of Principles and Standards planning procedures, the number

of agencies and programs directly involved in the planning process can be anticipated to be much greater than those considered in this Type 4 study. It is probable that all planned actions with a significant environmental, social, or economic impact will be planned jointly and coordinated with other agencies.

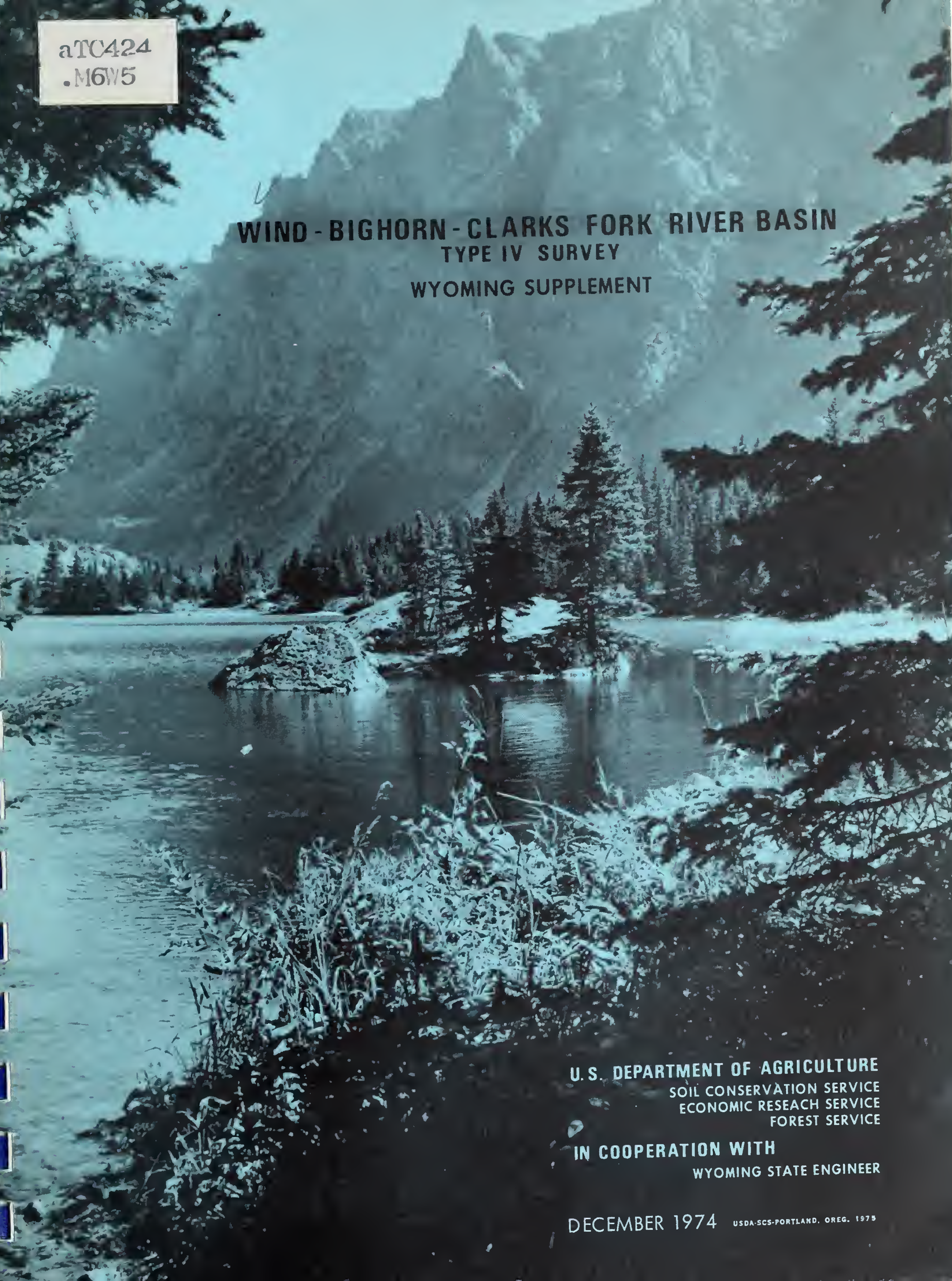
NEW PROGRAMS OR CRITERIA TO MEET NEEDS

Application of the Principles and Standards planning procedures to this study effort would significantly increase the need for interagency and public coordination in planning within the Basin. Application of the Principles and Standards would also have necessitated greater consideration of programs and alternatives outside the general responsibility of USDA. Because of the position of the Basin with respect to the urban center of Billings, the downstream coal fields of the Fort Union region, and the massive recreational complex of Yellowstone Park, this broader consideration may have helped make the study a more useful element in the State Water Plan.

POTENTIAL UTILIZATION BEYOND NEEDS OF BASIN--EXPORT

In the case of the Bighorn and Clarks Fork Rivers in Montana, downstream (and upstream) needs are of critical importance. At this date it appears that there is great likelihood that large-scale development of coal will occur downstream from the study Basin. The likely increased demand for industrial water may negate any plans for large-scale use of water within the Basin. On the other hand, this demand may necessitate planning for storage to satisfy this need. Another consideration, especially for in-stream uses of the water, involves the possible diversion of water from these streams before it enters the borders of Montana. If this should occur, it would probably be as a result of Wyoming's industrial demands.

aTC424
.M6W5



WIND - BIGHORN - CLARKS FORK RIVER BASIN
TYPE IV SURVEY
WYOMING SUPPLEMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMIC RESEACH SERVICE
FOREST SERVICE

IN COOPERATION WITH
WYOMING STATE ENGINEER

DECEMBER 1974 USDA-SCS-PORTLAND, OREG. 1975

AD-33 Bookplate
(1-63)

NATIONAL
AGRICULTURAL
LIBRARY

Cover Photo: Elk Lake

USDA - FOREST SERVICE PHOTO

WYOMING SUPPLEMENT

for the

WIND-BIGHORN-CLARKS FORK RIVER BASIN

Type IV Survey

USDA WATER AND RELATED LAND RESOURCES REPORT

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

JUN 27 1976

CATALOGING - PREP.

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE - FOREST SERVICE - SOIL CONSERVATION SERVICE

in cooperation with

WYOMING STATE ENGINEER

December 1974

Under Direction of

USDA FIELD ADVISORY COMMITTEE

395345

ADDENDUM

WIND-BIGHORN-CLARKS FORK RIVER BASIN

TYPE IV STUDY REPORTS

In accordance with Advisory RB-3 of February 4, 1974, and WTSC Advisory RB-PO-2 which refers to the Water Resource Development Act of 1973, the following statement is submitted:

> Potential projects described in this report have been evaluated at 5 5/8 percent discount rate.

The Wyoming Supplement Interim Report for this study was submitted to the Washington Advisory Committee in March 1973 and constituted a "draft report transmitted to WAC for review."

WIND-BIGHORN-CLARKS FORK RIVER BASIN
WYOMING SUPPLEMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

FIGURES

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

FOREWORD

It doesn't take a student of history to recognize the significance of the Wind-Bighorn-Clarks Fork River Basin. Along the banks of the Little Bighorn, Custer and his troops collected arrowheads. Lewis and Clark used many of these tributaries as highways to penetrate and explore the formidable barrier now known as the Continental Divide. Famous mountain men rendezvoused with Indians and fur companies on the banks of these famous rivers. It's a simple fact that water was the key to their survival as well as a primary source of income and a means to transport their goods. The same fact holds true for today's population. As Captain Clark and his hardy men floated their canoes down the Yellowstone River, they watched millions of acre-feet of water pound their way down toward the Gulf of Mexico. Today's observers realize that the rolling waters of the Wind-Bighorn-Clarks Fork Basin hold the key to the prosperity and well-being of many thousands of people.

Because heavy industry affects a small part of the basin, much of the landscape looks about the same today as it did when John Coulter left his moccasin prints in the dust and snow. Most of the 68,000 highly individualistic, livestock industry oriented residents might prefer to keep it that way.

This emotion is understandable but not completely realistic. From the standpoint of human needs, all of us, and particularly residents of the state, need some of the good things the basin has to offer. This plan is a proposal to enhance national, regional, and local economic development and at the same time protect environmental and human qualities. Two-thirds of the river basin is in Wyoming where the western boundary twists its way along the jagged peaks of the Continental Divide into the northwestern part of the state. Guarding the eastern perimeter of the basin looms the Big Horn Mountain Range. In between lie some of the wettest and driest lands found in any single river basin in the United States. Beaver and rendezvous are out; agriculture, oil, and tourism are in. Irrigated farmsteads nestled near the foothills and huge, far-flung ranches checkerboard the relatively flat lower lands of the basin. Scattered like orphans throughout the desert interior, thousands of "goony birds" patiently nurse millions of gallons of oil from deep in the earth. The cool temperatures and spectacular scenery of the basin and surrounding mountains attract a large number of tourists.

Starting with the Popo Agie (pronounced Po-'Po-Shia) at the extreme southern end of the Wind-Bighorn-Clarks Fork River Basin, all rivers and tributaries are children of the Yellowstone. Some begrimed by carelessness and some clean and sparkling, they dance and twist their way to the north until the family reunion is complete on the banks of the Yellowstone. Just south of Thermopolis, Wyoming, at the north end of the Wind River Canyon, is a spot called "The Wedding of the Waters." At this location the Wind River becomes the Bighorn River.

Custer might still be trying to get to the Little Bighorn if he had to negotiate his way through the maze of property divisions that exist in the basin today. His chances would be best by sticking to public lands managed by the Bureau of Land Management. More than 4,400,000 acres of public lands are strung out along the length and breadth of the basin. The going would be fairly easy, too. A good share of these lands are in flat to rolling terrain--some of it sparse desert land--where, as the old-timers say, "A horse has to gallop to graze." This public land is used mainly for the grazing of livestock.

The next biggest spread is the more than 3,000,000 acres under the brand of the U.S. Forest Service. Custer would have a rough go trying to get his troops through this country! Jagged peaks, heavy timber, deep canyons, spruce bogs, and rock fields surround the many, productive, high mountain parks. Snows all but close these national forests for 6 to 7 months each year. This closure, however, results in the most valuable resource in the basin--the snowpack. Here originates a major portion of the water for the Wind-Bighorn-Clarks Fork River Basin. This is headwaters country. From north to south, the west boundary is practically blocked out with the Shoshone National Forest. The east boundary is composed of the Big Horn National Forest and Bureau of Land Management lands.

There is a good reason why conservationists smile when the Wind-Bighorn-Clarks Fork Basin is mentioned! Conspicuous because of the large area they cover, and with names that sing of history and matchless beauty, seven areas classified either as wilderness or primitive areas frame the picture of the Wind-Bighorn-Clarks Fork River Basin. A name like Cloud Peak Primitive Area is enough to strike weak even the most callous industrialist. How about Beartooth Primitive Area; or Popo Agie Primitive Area; or Glacier Primitive Area; or, if you're geologically inclined, the Stratified Primitive Area? These areas are all under study for reclassification to wilderness status. The North and South Absaroka Wilderness Areas already have this designation.

By diminishing size, the next block of land ownership occurs in the private sector. These lands run a close second to the national forest with more than 2,700,000 acres. They consist primarily of farm and ranch operations with urban development an almost insignificant part of the land use pattern. There are almost 2,000,000 acres in the Wind River Indian Reservation. State-owned lands total about 604,000 acres. This figure includes nearly 20,000 acres under the jurisdiction of the State Game and Fish Department. The Bureau of Reclamation administers about 400,000 acres. Other federal agencies barely get in the picture with under 55,000 acres.

If you're a horned toad, there is some good news and some bad news. You'll love the desert-like interior of the basin where precipitation can be as little as 3 inches per year. However, near the 14,000 foot level at the Continental Divide you just wouldn't be happy with the drastic ecological change that results from as much as 70 inches of precipitation annually.

On the other hand, if you can make the adjustment, you may enjoy the solitude. There are more than 1,300,000 acres of designated wilderness and primitive areas to scamper around in. Surrounding these areas are about 1,600,000 acres of multiple use managed national forest lands with about 31,000 acres of state and private properties sprinkled around here and there inside the national forest boundaries to provide contrast.

You've heard the Indians speak of the "Happy Hunting Grounds"? Well, this must be the place! Inside the boundaries of the Wind-Bighorn-Clarks Fork River Basin is an astounding collection of big game species. Elk, deer, bear, moose, antelope, bighorn sheep, and mountain goats are found in the basin. Most of their habitat occurs on federal lands. Summer range is plentiful and presents no problem. Winter range is the big cause for concern. National forests provide about 276,000 acres for the winter grazing of big game animals. That sounds like a bunch until you consider that the basin supports many thousands of deer and elk. "Critical game winter range" is a designation rightfully tacked on large areas of land in the basin. If you think federal lands support all the wintering big game, talk to any of the many irate ranchers in the basin. They spend a generous amount of time each winter boarding up haystacks and repairing fences torn up by empty-bellied game animals that refuse to recognize man-made barriers and property boundaries.

"KEEP WYOMING GREEN" is a slogan that applies to more than just fire prevention. Ask any businessman about the green stuff scattered around by recreationists who visit the basin. Sightseeing, camping, hunting, fishing, guest ranches, and resorts are attractions of major significance which have a profound impact on the basin's economy.

We've been talking in generalities, and this is fine when we want to provide a panoramic "snapshot" of the basin as a whole. Interesting and sometimes startling information is revealed, however, when specific segments of the photo are blown up for a detailed look.

USDA SUPPLEMENTAL REPORT OF A STUDY OF WATER AND RELATED LAND RESOURCES OF THE WIND-BIGHORN-CLARKS FORK RIVER BASIN IN WYOMING

I. INTRODUCTION

This report presents the results of a study of problems and needs, potentials, and opportunities for the use and development of water and related land resources in the Wind-Bighorn-Clarks Fork River Basin in Wyoming. Opportunities for programs and projects which can be administered by agencies of the U. S. Department of Agriculture are identified.

This study is needed to provide information for a coordinated plan for systematic multipurpose development of the natural resources of this basin.

The objective of this study and report is to contribute to the coordinated and orderly development, management, and use of water and related land resources of the basin.

This report includes an inventory of natural resources, an analysis of economic development, an inventory of water and related land resource problems, and an identification of present and future needs for development of these resources. There is a discussion of existing projects and programs and an estimate of the development potential of these resources. A description of identified opportunities for U. S. Department of Agriculture programs and their impacts is part of the report. This report covers an area of about 20,590 square miles in north-central Wyoming. The mainstem of the Bighorn River flows northward and is fed by tributaries draining from high mountains on the western, southern, and eastern sides of the basin. The basin includes parts of the Beartooth, Absaroka, Wind River, and Big Horn Mountain Ranges. In the southern portion of the study area, the Wind River basin is separated from the Bighorn River basin by the Owl Creek Mountains, an intermediate range lying in a west to east direction. A portion of the Little Bighorn River basin is included in the study area. The population in the Wyoming portion of the basin was 68,407 in 1970. Dubois, Lander, Riverton, Thermopolis, Worland, Cody, Powell, and Lovell are the major towns.

This study has been made under the authority of Section VI of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). By this act the Secretary of Agriculture is authorized to cooperate with other federal, state, and local agencies in making investigations of watersheds, rivers, and other waterways. The Soil Conservation Service, Forest Service, and Economic Research Service of the U. S. Department of Agriculture have participated in this study in accordance with memorandums of understanding dated February 2, 1956, as revised April 15, 1968.

The State of Wyoming requested this study. A number of state agencies have cooperated by supplying data and field and office reviews of the study. The U. S. Bureau of Indian Affairs, the U. S. Bureau of Reclamation,

the U. S. Bureau of Land Management, and other federal agencies have provided data and otherwise contributed to the study. Close coordination was maintained throughout the study between the participating agencies and the sponsoring state agencies.

Employees of the Soil Conservation Service, Forest Service, and Economic Research Service have examined and analyzed existing source material and performed new field reconnaissance investigations. Economic studies included gathering data about the general economy, with special emphasis on the agricultural sector, identifying the relationships between and among factors that influenced the evolution of the economy, and projecting the volume and value of agricultural output. Estimates of gross farm income, employment, and use of rural lands were derived from analysis of historical and projected agricultural production.

An apprisal of potential small watershed projects and opportunities for other departmental programs has been made to estimate the extent to which these programs may help meet the needs for present and future development of water and related land resources in the basin. The intensity of investigation for potential watershed projects was similar to that usually followed in making preliminary investigations for such projects. Watershed investigation reports have been written for those watersheds where projects were found to be feasible.

The forest resources, their present use, volume, values of output, and impact on employment were evaluated. An estimate of future need for timber, range, recreation, fish, and wildlife has been made for the basin.

This report is a new source of data for water, land, and interrelated resources for the Wind-Bighorn-Clarks Fork River Basin area. It should be a very useful source of information for citizens in the basin and for local, state, and federal planning agencies interested in developing coordinated resource development in the basin and in guiding the investment of funds in the public interest.

Data, assistance, and cooperation in analysis of data and review of the report and project recommendations have been received from many local, state, and federal agencies. The following federal and state agencies contributed to the study:

Contributing agencies
Soil Conservation Service
Forest Service
Economic Research Service
Agricultural Stabilization and Conservation Service
Farmers Home Administration
Rural Electrification Administration
National Weather Service

Geological Survey
Statistical Reporting Service
Bureau of Land Management
Bureau of Reclamation
Corps of Engineers
Bureau of Sport Fisheries and Wildlife
Bureau of Outdoor Recreation
Bureau of Indian Affairs
Wyoming State Conservation Commission
Conservation Districts
Wyoming Department of Agriculture
Wyoming Game and Fish Department
Department of Economic Planning and Development
University of Wyoming
Wyoming State Engineer - Wyoming Water Planning Program
Wyoming State Forestry Division
Wyoming Water Quality Division
Wyoming Recreation Commission

II. NATURAL RESOURCES OF THE BASIN

The basic natural resources of the Wind-Bighorn-Clarks Fork River Basin are the building blocks with which to implement a plan for the development of the water of the basin. Consideration must be given to the location of the basin, the climate, physiography, geology, properties of the soils, land, water, vegetation, fish, wildlife, recreational resources, and other factors of the natural environment for proper planning of resource development. The quantity and quality of each of these natural resources affects the efficiency of the use and development of other resources. This chapter describes and contains inventories of many of these resources.

LOCATION AND SIZE

The Wyoming portion of the Wind-Bighorn-Clarks Fork River Basin is located in north central Wyoming as shown in figure II-1. Its boundary encompasses an area of about 13,179,000 acres, or about 20,590 square miles. This includes nearly all of Big Horn, Hot Springs, Park, and Washakie Counties; most of Fremont County; small portions of Johnson, Natrona, Sheridan, Teton, and Sublette Counties; and a small portion of Yellowstone National Park.

The basin is bordered by the Yellowstone, Snake, and Green River Basins on the west and the Platte, Powder, and Tongue River Basins on the south and east. Roughly heart-shaped, the basin averages 140 miles across from east to west and 160 miles from the southern boundary to the Wyoming-Montana state line. The basin may be divided into four hydrologic subbasins--the Wind, Bighorn, Clarks Fork, and Little Bighorn. Table II-1 lists respective sizes of each subbasin.

Table II-1--Areas of subbasins

Subbasin	Acres	Percent
Wind	4,992,740	38
Bighorn	7,196,060	55
Clarks Fork	796,570	6
Little Bighorn	193,670	1
Total	13,179,040	100

The Bighorn River and the Clarks Fork River are major tributaries of the Yellowstone River, itself a major tributary of the Missouri River. The Wyoming portion of the Wind-Bighorn-Clarks Fork Basin represents 4 percent of the area of the Missouri River Basin and 21 percent of the area of Wyoming.

CLIMATE

The climate of the basin varies from the cool, arid, desertic conditions prevailing at the lower elevations to the cold, humid, alpine zones in the higher mountain areas. This variation is influenced by the mountain ranges which lie in a general north-south direction, perpendicular to the prevailing westerlies. Winters are long and cold with occasional warm spells, and summers are short, dry, and warm. The spring season is cool with frequent periods of precipitation, and the fall season is cool and pleasant with occasional rain and snow storms.

Precipitation and, to a lesser extent, temperature vary with elevation. The average annual temperature at the town of Basin (elevation 3,860) is 45.7° F. and at Dubois (elevation 6,917) it is 40.5° F. Stations at lower elevations will frequently experience lower temperatures during cold periods because of the drainage of cold air from the mountains. Recorded extremes of temperature for the basin are -51° F. at Worland, Basin, and Lovell, and 114° F. at Basin. The growing season normally ranges from about 60 days near Dubois to 160 days near the town of Basin. In the high valleys and mountains, frost may occur any time during the year.

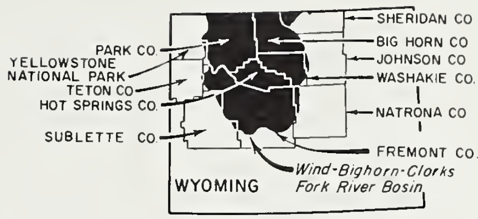
Average annual precipitation varies from less than 6 inches near the town of Basin along the Bighorn River to over 70 inches in the higher mountain ranges. At lower elevations about half of the annual precipitation occurs in scattered spring and summer thunderstorms. At higher elevations thunderstorms occur often in the summer, and snowfalls are frequent in the other seasons. Snowfall over the basin varies from an average of 15 to 20 inches at the lower elevations to over 200 inches in the mountains. A deep snowpack develops through the winter in the mountains and stores winter precipitation for release in high streamflows in the spring. Figure II-2 is a map of annual precipitation made as part of this study effort.

Evaporation losses are fairly high because of the low relative humidity and the high percentage of sunshine. Growing season evaporation varies from 40 to 60 inches at the lower elevations.

PHYSIOGRAPHY AND GEOLOGY

The basin is located within the Middle Rocky Mountains and Great Plains Divisions of the Northern Rockies and Great Plains Physiographic Provinces. It is bounded by the Bighorn Mountains, the Casper Arch, Beaver Rim, Wind River Mountains, the Absaroka Range, and the Pryor uplift. As mentioned before, there are four major subbasins. The rivers that drain these subbasins are primarily consequent streams that have cut deep canyons through the highlands which separate the subbasins.

The altitude of the basin floor ranges from 4,000 to 6,500 feet with elevations in the bordering mountains exceeding 12,000 feet. The highest



LOCATION MAP

FIGURE II-1

PROJECT MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

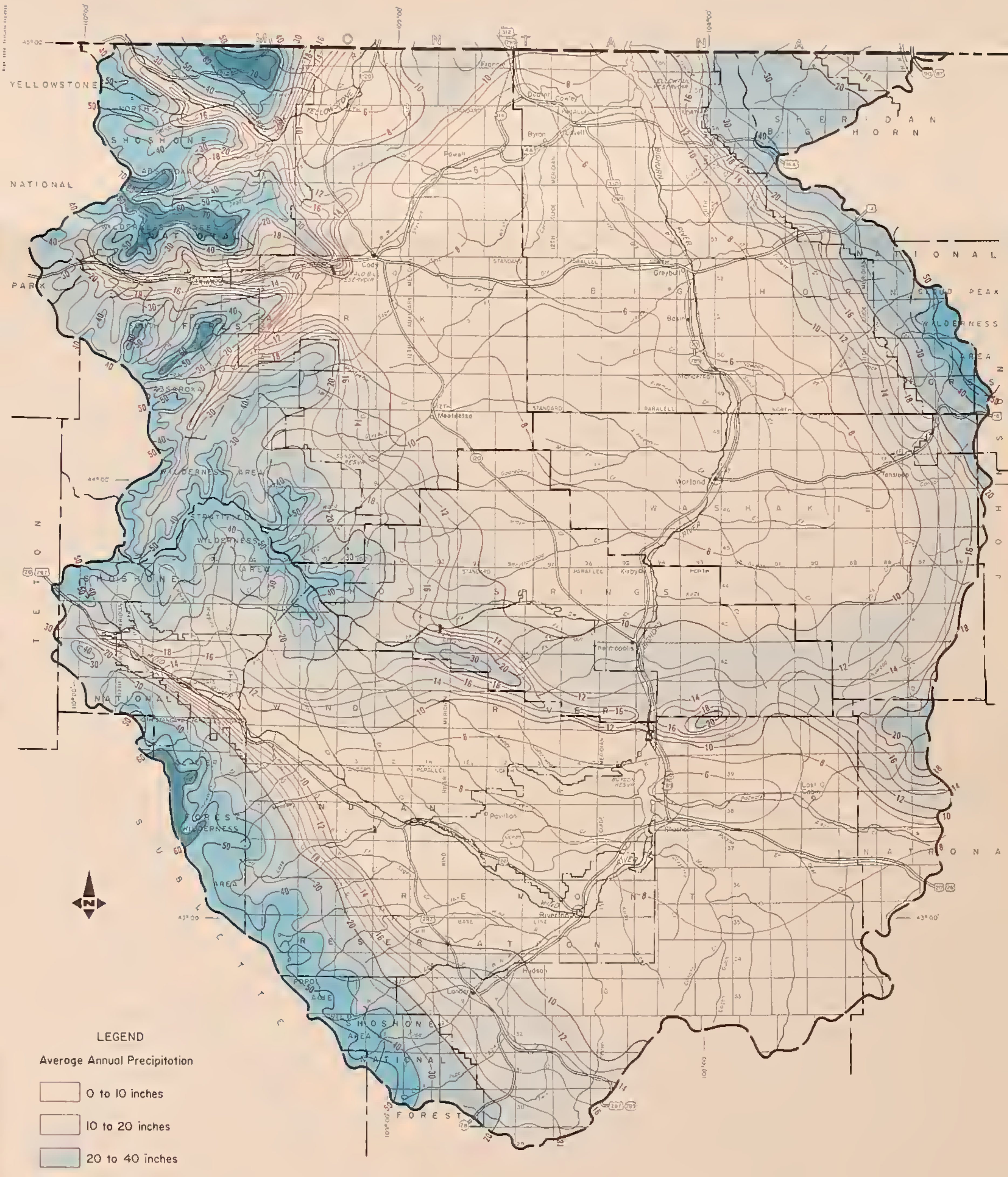
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,000,000

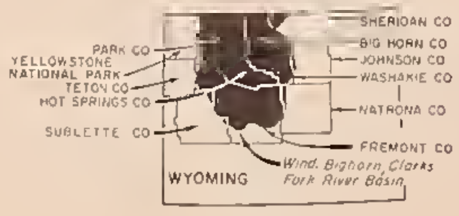
ALBERS EQUAL AREA PROJECTION



LEGEND

Average Annual Precipitation

- 0 to 10 inches
- 10 to 20 inches
- 20 to 40 inches
- 40 to 60 inches
- Over 60 inches



LOCATION MAP

FIGURE II-2

AVERAGE ANNUAL PRECIPITATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

M7-E-22780J-N

Winter lays a heavy blanket of snow on the mountains.

Soil moisture from snowmelt nourishes plants and animals in the spring.

PLATE 1

The deeply incised Bighorn Canyon now holds the water of Bighorn Lake. This magnificent scenic area, once very difficult to enter, can now be easily seen from a boat.

BUREAU OF RECLAMATION PHOTO

The Wind River Canyon--geologist's textbook, camper's delight, scenic wonder, and fisherman's paradise.

BUREAU OF RECLAMATION PHOTO

This basin produces an important part of the nation's oil supply.

PLATE 2

mountain is Gannet Peak at 13,785 feet, and the lowest point in elevation is slightly less than 3,500 feet where the Bighorn River leaves Wyoming.

The topography of the basin is very diverse ranging from high, alpine areas with permanent snow fields and glaciers to the desertic basin floor. These major features are interspersed with timbered footslopes, deep canyons, dissected lesser plateaus, sharp ridges, rugged badlands, and terraced river valleys. The wide range in erosion resistance of the underlying rock layers is the principal factor in development of these features. Figure II-3 is a generalized geology map of the basin. The more resistant rocks stand as erosional remnants or in high relief while the softer rocks have been eroded into open valleys. The precipitous canyons along the footslopes have been cut into durable rock over a prolonged period by swift flowing streams.

The geologic formations in the basin range in age from Precambrian to Quaternary with all intervening ages expect for the Silurian being represented. Crystalline rocks of Precambrian Age are exposed along the high mountain divides on the outer margin of the basin with the exception of the Absaroka Range, which is composed of volcanic extrusive and intrusive rocks of Tertiary Age. Paleozoic and Mesozoic sedimentary rocks occur around the flanks of the basin. The floor of the basin contains sedimentary rocks of Tertiary Age, while unconsolidated alluvium of Quaternary Age occurs along the river valleys.

Several periods of movement of the earth's crust took place in the basin during Precambrian time. This faulting and folding played a major role in determining the form of the rim of the present basin. The area was generally quiescent during Paleozoic and Mesozoic time with only local vertical adjustment with associated folding occurring during this long period of time. This relatively inactive tectonic period ended with the start of the Laramide orogeny which reached its peak in late Paleocene to early Eocene time. This mountain building period was closely followed by volcanic activity along the northwest margin of the basin where thousands of cubic miles of pyroclastic rocks were extruded. The basin was then filled with sediments to nearly a plain with only the core of the mountains protruding above the plain. The area was then upwarped and faulted and rejuvenated erosion resulted in canyon cutting and reexcavation of the basin. Local volcanic activity also occurred at this time. Subsequent periods of alpine glaciation and erosion have modified the basin into its present form.

MINERAL RESOURCES

Petroleum, natural gas, uranium, iron, bentonite, gypsum, and sulfur are presently the most important minerals being produced in the basin. Current annual oil production is between 65 to 70 million barrels, while gas production is about 75 billion cubic feet annually from oil and gas fields scattered throughout the basin. Associated sulphur production from sour gas is about 30,000 long tons per year.

About 2 million tons of uranium ore are processed annually, primarily by three mills located in the Gas Hills area southeast of Riverton. An iron mill on the basin boundary southwest of Lander processes some 4 million tons of raw iron ore per year. About 875,000 tons of bentonite are produced annually in the Greybull area. Gypsum production amounts to 350,000 tons per year primarily in the Cody-Lovell area. Clay deposits are processed for tile in the Lovell area, and feldspar is being mined on Copper Mountain near Boysen Reservoir.

Significant reserves of good grade bituminous coal occur in the basin. Large amounts have been produced in the past, but production is presently limited to small amounts for local use. Sand and gravel deposits occur along the mainstem drainages and are produced locally. Phosphate, limestone, and building stone quarries occur but are currently of no significant commercial importance. Copper, lead, gold, and other metals associated with the Precambrian rocks occur in significant quantities to have been mined in the past, but because of economic conditions, are no longer produced.

LAND RESOURCES

Land is one of the basic resources used by man and is the most common resource in private ownership. The value of land for agricultural use varies with its productive capacity. This potential capacity is dictated by soils type, climate, vegetative cover, and the availability of water. Land ownership, soils, vegetative cover, and land uses in the basin are described in this section.

Land ownership and administration

Data on land ownership and administration is given in tables II-2 and II-3 by watersheds, subbasins, and counties. A map of land ownership is on figure II-4. About 60 percent of the basin is public lands with 23 percent administered by the U. S. Forest Service, 33.6 percent by the Bureau of Land Management, 3.1 percent by the Bureau of Reclamation, 0.4 percent by other federal agencies, and 4.6 percent by the state. The remaining lands are in private ownership held either by individuals, corporations, or the Arapahoe and Shoshone Indian tribes on the Wind River Indian Reservation.

Lands administered by the U. S. Forest Service are in the Shoshone National Forest (2,468,880 acres) and the Big Horn National Forest (556,710 acres). Lands administered by the Bureau of Land Management are primarily desert and range lands in the lower elevations of the basin.

Lands set aside by the Bureau of Reclamation are intended to be irrigated by reclamation projects. These lands are normally administered in cooperation with the Bureau of Land Management. State lands are those used by the Wyoming Game and Fish Commission (19,960 acres) and by other state agencies and include "school" lands (584,340 acres).

LEGEND

- Qal — Quaternary Alluvium
- Qt — Quaternary Terrace
- Ti — Tertiary Intrusive Volcanics
- Te — Tertiary Extrusive Volcanics
- Tmo — Miocene & Oligocene Undivided
- Teum — Upper & Middle Eocene Rocks Undivided
- Twr — Tertiary Wind River Formation
- Tw — Tertiary Wasatch Formation
- Tfu — Tertiary Fort Union Formation
- Klmv — Cretaceous Lance, Meeteetse, & Meseverde Formations
- Kc — Cretaceous Colorado Group
- K — Cretaceous Cloverly, Morrison Formations
- J — Jurassic Rocks Undivided
- Ћ — Triassic Rocks Undivided
- ℙp — Pennsylvanian & Permian Rocks Undivided
- Cm — Mississippian Undivided
- D-Є — Devonian to Cambrian Rocks Undivided
- pЄ — Pre-Cambrain Granite
- Fault
- Inverted Fault

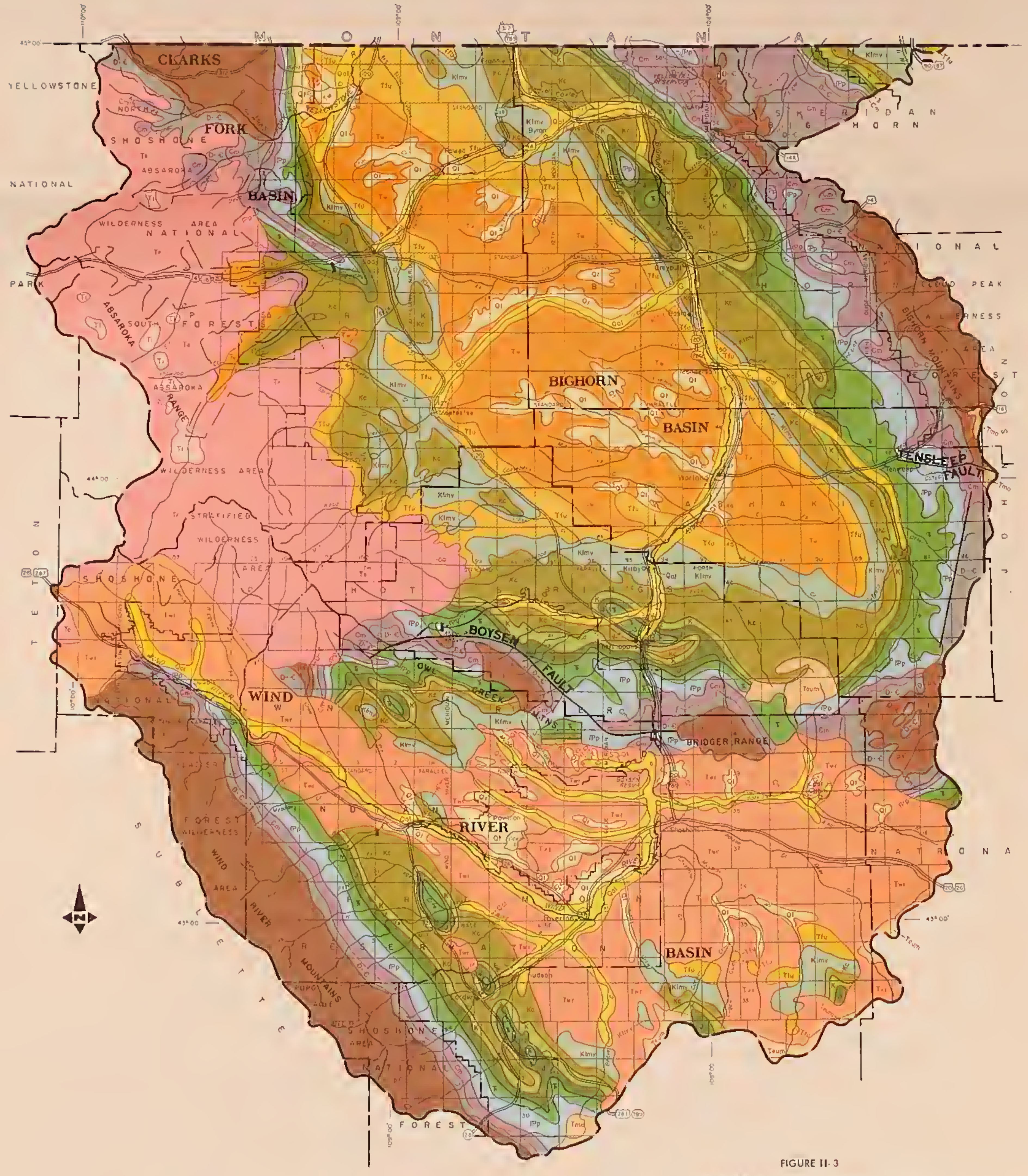


FIGURE II-3

GENERALIZED GEOLOGY

WIND · BIGHORN · CLARKS FORK RIVER BASIN

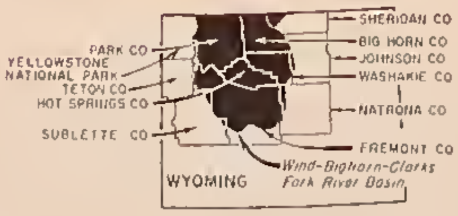
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

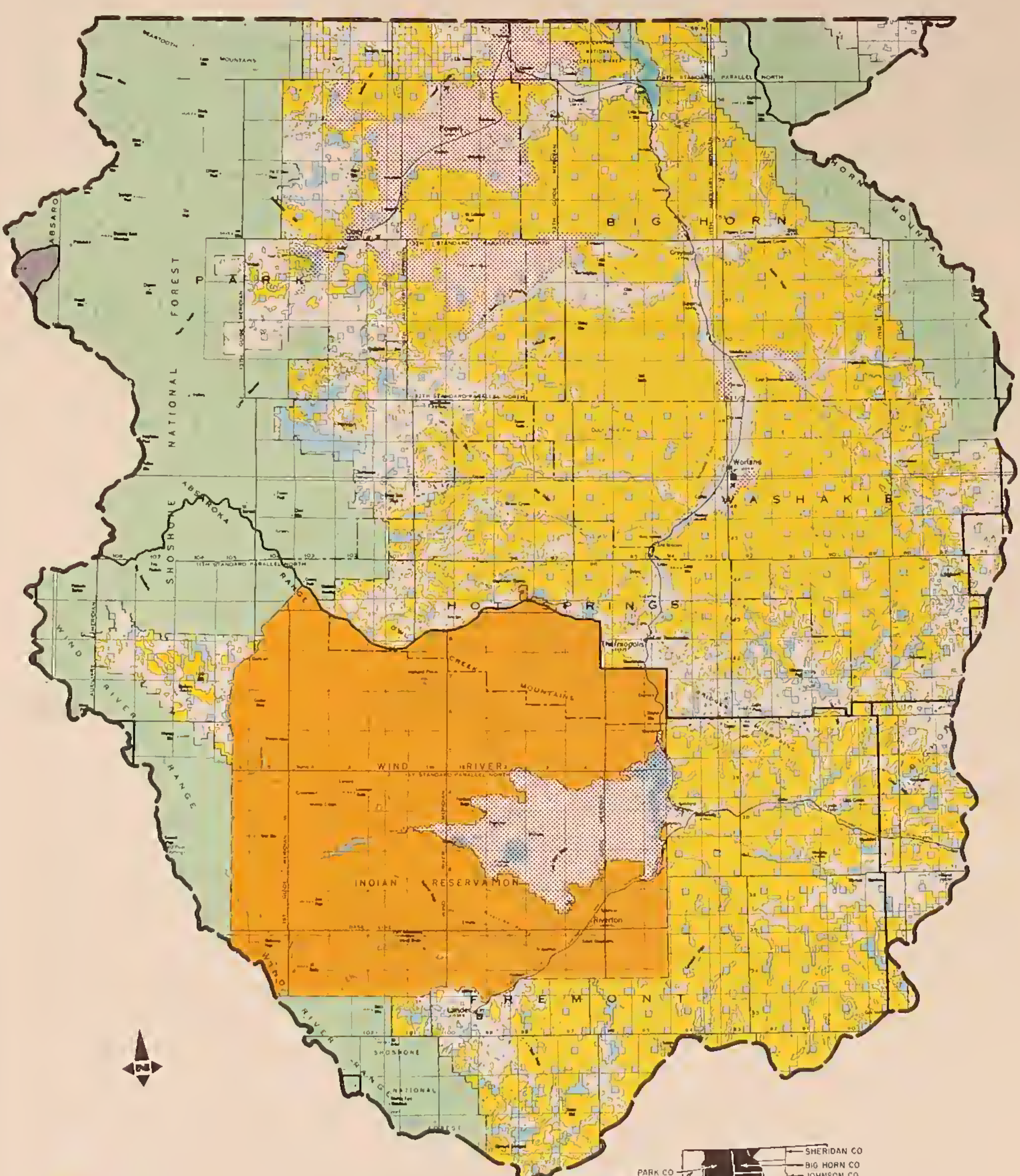
DECEMBER 1974

10 0 10 20 MILES

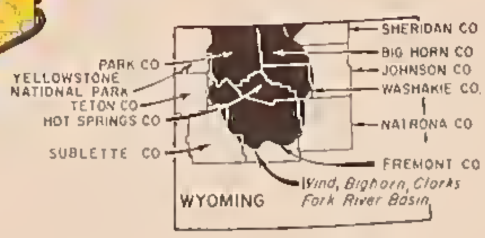
SCALE 1:1,000,000



LOCATION MAP



Public Lands
National Parks and Monuments
B. L. M. Aquired Land
Indian Reservation
State Lands
Private Lands
National Forests
Bureau of Reclamation Jurisdiction
Prior Mountian Wild Horse and Wildlife Range
National Recreation Areas



LOCATION MAP

FIGURE II-4

LAND OWNERSHIP & ADMINISTRATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

M7-N-22780R

Table II-2--Surface ownership and administration by counties in the Wind-Bighorn-Clarks Fork River Basin, January 1972

Political Subdivision	Unit	Area in the Basin	Private: Private Ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies	Percent of political sub-division
Big Horn Co.	acres	2,001,320	361,280	0	920	74,680	1,130,880	337,160	50,440	25,960	
	percent	15.2	18.1	0	0.1	3.7	56.5	17.8	2.5	1.3	100.0
Fremont Co.	acres	4,628,090	578,550	1,687,310	11,360	154,880	1,162,610	860,520	162,340	10,520	
	percent	35.1	12.5	36.5	0.2	3.4	25.1	18.6	3.5	0.2	78.0
Hot Springs Co.	acres	1,337,110	391,000	265,790	0	76,500	540,980	59,760	3,080	0	
	percent	10.1	29.2	19.9	0	5.7	40.5	4.5	0.2	0	100.0
Johnson Co.	acres	36,420	16,030	0	0	560	1,280	18,550	0	0	
	percent	0.3	44.0	0	0	1.5	3.5	51.0	0	0	1.4
Natrona Co.	acres	340,480	161,200	0	0	37,560	141,720	0	0	0	
	percent	2.6	47.4	0	0	11.0	41.6	0	0	0	9.9
Park Co.	acres	3,186,260 3/	815,530	0	1,640	142,180	493,370	1,540,290	193,230	0	
	percent	24.2	25.6	0	0.1	4.4	15.5	48.3	6.1	0	95.1
Sheridan Co.	acres	193,660	41,050	0	4,800	4,140	280	143,230	0	160	
	percent	1.5	21.2	0	2.5	2.1	0.1	74.0	0	0.1	12.0
Sublette Co.	acres	8,290	0	0	0	0	0	8,290	0	0	
	percent	0.1	0	0	0	0	0	100.0	0	0	.3
Teton Co.	acres	2,560	0	0	0	0	0	2,560	0	0	
	percent	-- 1/	0	0	0	0	0	100.0	0	0	0.1
Washakie Co.	acres	1,426,600	338,020	0	1,240	93,840	955,030	35,230	3,240	0	
	percent	10.8	23.7	0	0.1	6.6	66.9	2.5	0.2	0	99.0
Yellowstone Park	acres	18,250	0	0	0	0	0	0	0	18,250	
	percent	0.1	0	0	0	0	0	0	0	100.0	0.9
Total	acres	13,179,040	2,702,660	1,953,100 2/	19,960	584,340	4,426,150	3,025,590	412,350	54,890	
	percent	100.0	20.5	14.8	0.2	4.4	33.6	23.0	3.1	0.4	

1/ -- = less than 0.1 percent.
2/ This area may include some land in private, non-Indian ownership. The BIA published data for this area is 1,886,374 acres.
3/ No part of Yellowstone National Park is included in this figure.

Table II-3--Surface ownership and administration in the Wind-Bighorn-Clarks Fork River Basin by watersheds and subbasins, January 1972

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
	Wind River Subbasin	acres								
14e-1	Upper Poison Creek	230,570	118,410	0	0	25,760	86,400	0	0	0
14e-3	Lower Poison Creek	103,080	11,040	2,280	0	5,160	79,920	0	4,680	0
14e-4	Fivemile Creek	122,150	2,780	115,370	0	0	0	0	4,000	0
14e-5	Muddy Creek	244,180	0	192,960	0	0	880	0	50,340	0
14e-6	Dry Muddy Creek	142,220	0	112,260	0	0	0	0	29,080	880
14el-1	Upper Wind River	143,930	21,360	0	0	1,920	3,880	116,770	0	0
14el-1a	Horse Creek	104,900	31,400	0	0	7,520	18,930	47,050	0	0
14el-2	Wiggins Fork	143,430	8,030	0	3,760	6,080	6,680	118,880	0	0
14el-3	Jakey's Fork-Torrey Creek	187,800	25,320	6,200	3,240	1,800	6,080	145,160	0	0
14el-4	East Fork	139,590	10,480	13,750	680	2,800	3,120	108,760	0	0
14el-5	Crow Creek	118,010	0	118,010	0	0	0	0	0	0
14el-6	Dinwoody Creek	245,400	0	166,000	0	0	0	79,400	0	0
14el-7	Bull Lake	163,190	0	120,710	0	0	0	42,200	280	0
14el-8	Crowheart Butte-Dry Creek	168,940	7,240	161,700	0	0	0	0	0	0
14el-9	Midvale	180,540	104,640	10,620	2,160	0	0	0	53,480	9,640
14el-10	Riverton	125,470	600	113,420	0	0	0	0	11,450	0
14el-12	Kirby Draw	125,770	3,440	95,920	0	960	24,090	0	1,360	0
14ela-1	Little Popo Agie	238,630	48,840	0	1,360	18,240	117,630	52,560	0	0
14ela-2	Middle Popo Agie	166,120	58,840	0	160	9,280	14,080	83,760	0	0
14ela-2a	North Popo Agie	117,600	12,280	36,540	0	3,400	8,960	56,420	0	0
14ela-3	South Lower Little Wind	109,940	0	109,900	0	0	0	40	0	0
14ela-4	Upper Little Wind	161,990	0	146,110	0	0	0	15,880	0	0
14ela-4a	North Lower Little Wind	159,760	0	159,760	0	0	0	0	0	0
14ela-5	Upper Beaver Creek	180,750	40,360	0	0	14,000	122,090	4,300	0	0
14ela-6	Lower Beaver Creek	94,210	2,200	19,580	0	6,640	65,790	0	0	0
14e2-1	Muskrat	246,910	29,240	1,080	0	17,720	197,510	0	1,360	0
14e2-2	Conant Creek	178,320	14,320	0	0	12,400	151,360	0	240	0
14e2-3	Lower Muskrat	59,910	1,840	720	0	3,080	54,270	0	0	0
14e3-1	Alkali Creek	149,400	35,160	0	0	16,000	98,320	0	0	0
14e3-2	Upper Badwater Creek	133,840	55,720	0	0	14,560	63,560	0	0	0
14e3-3	Bridger Creek	117,800	58,880	0	0	6,380	52,540	0	0	0
14e3-4	Lower Badwater Creek	188,310	33,400	180	0	16,000	131,780	0	6,950	0
	Subtotal of 32 watersheds	4,992,740	735,820	1,703,070	11,360	189,700	1,307,870	871,180	163,220	10,520
	Percent of subbasin	100.0	14.7	34.1	0.2	3.8	26.2	17.4	3.3	0.2
	Percent of basin total ownership	31.9	27.0	87.2	56.9	32.5	29.5	29.0	39.6	19.2

Table II-3--Surface ownership and administration (Continued)

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
	Bighorn River Subbasin	acres								
14e-6a	Red Canyon Creek	100,960	7,280	87,560	0	0	6,120	0	0	0
14e-7	Buffalo Creek	93,900	64,660	7,200	0	9,840	12,200	0	0	0
14e-8	Upper South Fork Owl Creek	81,100	27,120	26,040	0	2,560	16,740	7,480	1,160	0
14e-8a	Upper Owl Creek	163,700	45,160	64,620	0	6,440	38,080	9,280	120	0
14e-9	Mud Creek	78,170	7,720	64,610	0	0	5,840	0	0	0
14e-10	Candy Jack	1,410	570	0	0	320	520	0	0	0
14e-10a	East Thermopolis	21,690	10,690	0	0	6,280	4,720	0	0	0
14e-10b	Lucerne	24,710	13,710	0	0	1,640	9,280	0	80	0
14e-10c	Upper Hanover	37,620	9,080	0	0	1,080	27,100	0	360	0
14e-11	Kirby Creek	169,140	49,720	0	0	15,480	103,940	0	0	0
14e-12	No Water Creek	164,100	23,800	0	0	7,640	132,660	0	0	0
14e-12a	East Fork No Water Creek	100,760	0	0	0	6,720	93,960	0	80	0
14e-13	Gebo Mine	85,630	11,120	0	0	4,160	70,310	0	40	0
14e-14	Upper Cottonwood	125,670	38,440	0	0	6,880	74,150	6,160	40	0
14e-15	Gooseberry Creek	232,290	68,840	0	0	18,000	136,150	8,580	720	0
14e-16	Lower Cottonwood	176,100	52,080	0	0	15,320	107,940	720	40	0
14e-17	Colter	16,340	4,120	0	0	920	11,300	0	0	0
14e-17a	WA Sage	9,880	7,600	0	0	0	2,200	0	80	0
14e-17b	Lower Hanover	49,730	28,050	0	0	2,640	17,600	0	1,440	0
14e-19	Upper Fifteenmile	105,600	32,680	0	0	5,040	67,880	0	0	0
14e-20	Lower Fifteenmile	235,010	11,040	0	0	10,900	213,070	0	0	0
14e-21	Fivemile-Elk Creek	187,400	30,790	0	0	5,160	148,410	0	3,040	0
14e-22	Upper Shell Creek	168,440	23,560	0	0	1,280	47,100	96,500	0	0
14e-23	Lower Shell Creek	204,540	27,160	0	0	8,800	130,660	37,920	0	0
14e-24	Bear Creek	73,630	4,800	0	0	3,600	61,950	3,000	280	0
14e-24a	Crystal Creek	115,180	21,520	0	0	4,520	62,930	21,290	400	4,520
14e-25	Dry Creek	246,910	32,840	0	0	11,080	81,480	0	121,510	0
14e-26	Little Dry Creek	105,500	5,720	0	0	5,200	92,580	0	2,000	0
14e-27	Crooked Creek	20,680	2,280	0	0	440	11,200	0	0	6,760
14e-28	Porcupine Creek	97,630	10,280	0	0	3,960	37,060	40,570	120	5,640
14e4-1	Upper Nowood	233,490	142,330	0	0	25,120	65,320	0	720	0
14e4-2	Buffalo Creek	112,960	14,400	0	0	10,080	88,440	0	40	0
14e4-3	Middle Nowood	182,670	82,470	0	0	16,760	83,440	0	0	0
14e4-4	Tensleep Creek	167,430	48,440	0	1,240	3,720	20,880	92,630	520	0
14e4-5	Bonanza	180,840	23,400	0	0	10,520	142,960	3,880	80	0
14e4-6	Paintrock Creek	245,000	29,820	0	0	11,140	88,600	115,140	300	0
14e4-7	Lower Nowood	208,980	17,200	0	0	9,080	182,180	0	520	0
14e5-1	Wood River	183,470	36,860	0	0	19,840	960	125,770	40	0

Table II-3--Surface ownership and administration (Continued)

Watershed number	Watershed name	Area in watershed	Private: Private ownership	Private: Wind River Indian Reservation	State: Game and Fish Commission	State: Other state land	Federal: Bureau of Land Management	Federal: National Forest	Federal: Bureau of Reclamation	Federal: Other federal agencies
	Bighorn River Subbasin (cont'd)	--acres--								
14e5-2	Upper Greybull	182,560	5,840	0	0	17,840	4,480	154,400	0	0
14e5-3	Meeteetse	212,910	147,110	0	0	24,960	34,640	6,000	200	0
14e5-4	Lower Greybull	202,930	89,610	0	0	7,200	105,560	0	560	0
14e6-1	Shoshone Plateau	111,350	0	0	0	0	0	111,350	0	0
14e6-2	Upper South Fork Shoshone	188,720	14,580	0	0	0	1,380	172,760	0	0
14e6-3	Lower South Fork Shoshone	234,810	143,050	0	0	16,920	34,120	29,680	11,040	0
14e6-5	Whistle Creek	138,180	20,520	0	0	6,240	86,700	0	24,720	0
14e6-6	Heart Mountain-Powell	249,940	167,620	0	40	10,440	43,400	0	28,440	0
14e6-7	Lovell-Kane	163,400	26,080	0	0	6,960	123,840	0	3,280	3,240
14e6-8	Sage Creek-Pryor Mountain	100,760	66,240	0	0	4,200	14,400	0	15,920	0
14e6-8a	North Lovell-Dry Creek	53,260	3,840	0	920	1,400	32,060	0	9,240	5,800
14e6a-1	Sylvan Pass	235,810	200	0	0	0	0	217,360	0	18,250
14e6a-2	Wapiti	144,130	14,080	0	0	1,000	11,960	116,890	200	0
14e6a-2a	Trout Creek	169,040	15,280	0	0	1,400	14,400	137,240	720	0
	Subtotal of 52 watersheds	7,196,060	1,781,400	250,030	2,200	370,720	3,004,850	1,514,600	228,050	44,210
	Percent of subbasin	100.0	24.8	3.5	0.1	5.1	41.7	21.0	3.2	0.6
	Percent of basin total ownership	54.6	65.3	12.8	11.0	63.4	69.9	50.5	55.3	80.5
	Clarks Fork Subbasin									
14c-1	Sunlight Basin	147,910	3,610	0	1,400	0	0	142,900	0	0
14c-2	Crandell Creek	117,640	1,260	0	0	0	0	116,380	0	0
14c-3	Clarks Fork	140,020	2,660	0	0	0	0	137,360	0	0
14c-4	Pat O'Hara	130,750	53,330	0	0	11,740	25,320	26,120	14,240	0
14c-4a	Big Sand Coulee	86,580	27,720	0	0	4,600	47,940	0	6,320	0
14c-5	Cyclone Bar	108,920	25,490	0	200	2,720	15,780	64,450	280	0
14c-6	Elk Basin	51,200	27,560	0	0	720	22,680	0	240	0
14c-7	Clarks Fork-Ruby Creek	4,180	2,760	0	0	0	1,420	0	0	0
14c-8	Upper Rock Creek	9,370	0	0	0	0	0	9,370	0	0
	Subtotal of 9 watersheds	796,570	144,390	0	1,600	19,780	113,140	496,580	21,080	0
	Percent of subbasin	100.0	18.1	0	0.2	2.5	14.2	62.4	2.6	0
	Percent of basin total ownership	6.0	5.3	0	8.0	3.4	2.6	15.7	5.1	0
	Little Bighorn Subbasin									
14e7-1	Little Bighorn River	123,520	5,240	0	1,560	0	0	116,560	0	160
14e7-2	Pass Creek	54,400	35,240	0	3,240	3,960	240	11,720	0	0
14e7-3	Lodge Grass Creek	14,950	0	0	0	0	0	14,950	0	0
14e7-4	Owl Creek	800	570	0	0	180	50	0	0	0
	Subtotal of 4 watersheds	193,670	41,050	0	4,800	4,140	290	143,230	0	160
	Percent of subbasin	100.0	21.2	0	2.5	2.1	0.1	74.0	0	0.1
	Percent of basin total ownership	1.5	1.5		24.1	0.7	0.0	4.8	0	0.3
	TOTAL	13,179,040	2,702,660	1,953,100 1/	19,960	584,340	4,426,150	3,025,590	412,350	54,890
	Percent of Total	100.0	20.5	14.8	0.2	4.4	33.6	23.0	3.1	0.4

1/ This area may include some land in private, non-Indian ownership. The BIA data for this area is 1,685,080 acres.

Land resource areas

Land resource units are geographic areas of land, usually several thousand acres in extent that are characterized by particular soil patterns (including slope and erosion), climate, water resources, land use, and type of farming. A unit may occur as one continuous area or as several separate but nearby areas and are the basic mapping unit on state land resource maps.

Major land resource areas (LRA) consist of geographically associated land resource units and are mapped and described in Agriculture Handbook 296, "Land resource regions and major land resource areas of the United States," USDA, 1965. Table II-4 lists these major land resource areas within the basin in Wyoming.

Land resource regions consist of geographically associated major land resource areas. Two of these regions--the Western Range and Irrigated Region and the Rocky Mountain Range and Forest Region are partly in this river basin.

Table II-4--Land resource regions and areas

Land resource region and area	Portion of total basin area
	--------percent---------
Western Range and Irrigated Region	
32 Northern Intermountain Desertic Basins	32
33 Semiarid Rocky Mountains	7
34 Central Desertic Plains	18
Rocky Mountain Range and Forest Region	
43 Northern Rocky Mountains	27
45 Alpine Meadows and Rockland	3
46 Northern Rocky Mountain Foothills	13

Soils

The wide variety of soils in the Wind-Bighorn-Clarks Fork River Basin is due basically to the several kinds and origins of the parent materials and to variations in climatic conditions. A generalized soils map and simplified legend is shown in figure II-5. The following paragraphs provide a general description of the soils found in each Land Resource area. The table with the map lists general descriptions of selected soil properties of dominant soils in each of the general soils areas. Each general soil area will have soil with properties not reflected in the table.

The Northern Intermountain Desertic Basins Land Resource Area comprises about 32 percent of the total basin area. Much of the land is used for grazing. The native vegetation consists mostly of desert shrubs and brush, but short and mid-grasses grow on the more favorable sites. Most of the irrigated land in the basin is in this land resource area and is used to produce hay, grain, and row crops. Elevations are 3,800 to 6,000 feet. The annual precipitation is from 5 to 14 inches. Most of these soils in the irrigated area of the Bighorn Subbasin are deep, well to poorly drained, light colored, loamy and clayey soils which formed in alluvium on flood plains, stream terraces, and alluvial fans. They are moderately to strongly alkaline, and some moderately to strongly saline. Most of these soils in the Riverton irrigated area are shallow to deep, well drained, light colored, loamy soils which formed in alluvium or residuum from interbedded shale and sandstone on gently sloping to sloping alluvial fans, stream terraces, and uplands. These soils are moderately to strongly alkaline, and some of them are moderately to strongly saline. In the nonirrigated parts of this land resource area the soils are: Deep, well drained, light colored, moderately alkaline, loamy soils which formed in alluvial deposits on nearly level to sloping high terraces; shallow to deep, well drained, light colored, moderately to strongly alkaline, loamy and clayey soils which formed in material weathered from shale on nearly level to sloping uplands; and deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy and clayey soils which formed in material weathered from shale on nearly level to sloping uplands; and deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy to clayey soils which formed in material weathered from interbedded sandstone and shale on undulating to rolling, and strongly dissected, steep uplands.

The soils in mountain areas of the basin are in three land resource areas--the Semiarid Rocky Mountains, Northern Rocky Mountains, and Alpine Meadows and Rockland. The Semiarid Rocky Mountains LRA, which comprises about 7 percent of the total basin area, is largely used for grazing. Desert shrubs, mid-grasses, and mountain shrubs cover most of this area. Small areas in isolated valleys are irrigated and used for producing hay and grain. Elevations range from 6,000 to more than 8,000 feet, and the average annual precipitation is 12 to 16 inches. Most of the soils are shallow to deep, well drained, dark colored, loamy soils which formed in materials weathered from sandstone, limestone, and dolomite on steep, strongly dissected mountain fronts with many rock outcrops and some steep canyons. Also included are some deep and shallow, well drained, light colored, loamy soils which formed in materials weathered from interbedded shale and sandstone on dissected to rough, broken uplands.

The Central Desertic Basins, Mountains, and Plateaus LRA comprise about 18 percent of the total basin area. It is used mostly for cattle and sheep grazing. The native vegetation is sagebrush, greasewood, other desert shrubs, and short and mid-grasses. Small areas along the larger streams are irrigated and used to produce hay and pasture. Elevations range from 4,500 to 7,500 feet. The annual precipitation is 7 to 12 inches. Most of the soils in this LRA are deep to shallow, well drained, light colored, moderately to strongly alkaline, loamy to clayey soils which formed

Soil scientists obtain basic soils information.

Knowledge about his soil is essential to the successful rancher.

PLATE 3

Surface water from mountain snowmelt is diverted in the summer to irrigate croplands.

Grass or brushland range is the most extensive land use in the basin.

Forest land is defined as land at least 10 percent stocked by trees of any size.

U.S. FOREST SERVICE PHOTO

PLATE 4

Soil associations and selected soil properties and qualities of dominant soils--Wind-Bighorn-Clarks Fork River Basin.

Map symbol	Soil association	Area percent	Components	Inclusions	Percent	Dominant soil series or family particle-size class	Position	Slope 1/ (percent)	Elevation (feet)	Mean annual soil temperature (Degrees F.)	Frost-free season (days)	Vegetation	Depth of soil (inches)	Drainage	Texture surface layer	Texture of Subsoil or Underlying layer	Permeability	Available water capacity	Shrink-swell	Reaction (pH)	Salinity	Runoff	Erosion hazard K	Erosion hazard T	Erosion hazard WEG	Potential frost action	Hydrologic group	Major land uses
C1	Cryoborolls-Cryoboralfs-Rock outcrop association	17	Cryoborolls		30	Fine-loamy	Mountains	10–30	6,900–12,495	>47	—	Shrubs and grass	40–60	Well	Loam	Loam or clay loam	Moderate	Moderate to high	Moderate	6.6–7.3	—	Rapid	.32	4	6	Moderate	B	Recreation, wildlife habitat
			Cryoboralfs		30	Fine-loamy	Mountains	30–70	7,200–13,785	>47	—	Coniferous trees	20–40	Well	Loam	Loam or clay loam	Moderate	Low to Moderate	Moderate	5.6–6.5	—	Rapid	.32	3	6	Moderate	C	Recreation, wildlife habitat
			Rock outcrop		30	—	Mountains	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryochrepts 10%																								
C2	Cryoboralfs-Rock outcrop association	6	Cryoboralfs		35	Loamy-skeletal	Mountains	30–70	7,200–13,785	>47	—	Coniferous trees	20–40	Well	Very stony sandy loam	Very gravelly sandy clay loam	Moderate	Low	Moderate	5.6–6.5	—	Rapid	.17	3	3	Moderate	C	Recreation, wildlife habitat
			Rock outcrop		30	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryoborolls 20% Cryochrepts 10% Others 5%																								
C3	Cryoborolls-Rock outcrop association	11	Cryoborolls		40	Fine-loamy	Mountains	10–30	6,900–13,165	>47	—	Shrubs and grass	40–60	Well	Loam	Loam or clay loam	Moderate	Moderate to high	Moderate	6.6–7.3	—	Rapid	.32	4	6	Moderate	B	Recreation, wildlife habitat, grazing
			Rock outcrop		30	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Cryoboralfs 20% Others 10%																								
F1	Haplargids-Argiborolls association	3	Haplargids		40	Fine-loamy	Alluvial fans and high terraces	0–20	5,200–7,200	>47	90–120	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Moderate	Moderate	6.6–8.4	—	Slow to rapid	.32	5	6	Low	B	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Argiborolls		20	Fine-loamy	Terraces and alluvial fans	6–20	5,200–7,200	>47	90–120	Shrubs and grass	>60	Well	Sandy loam	Clay loam	Moderate	Moderate to high	Moderate	6.6–7.3	—	Medium to rapid	.24	5	3	Low	B	
				Torriorthents 10% Torrifluvents 10% Others 20%																								
F2	Haplargids-Camborthids-Torriorthents association	10	Haplargids		35	Fine-loamy	Uplands	2–15	5,200–7,200	>47	90–120	Shrubs and grass	20–40	Well	Loam	Clay loam	Moderate	Low	Moderate	6.6–8.4	—	Medium to rapid	.32	3	6	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Camborthids		25	Fine-loamy	Uplands	2–40	5,200–7,200	>47	90–120	Shrubs and grass	20–40	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	8.4–9.0	—	Medium to rapid	.37	3	4L	Low	C	
			Torriorthents		20	Loamy, shallow	Uplands	2–40	5,200–7,200	>47	90–120	Shrubs and grass	10–20	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	8.4–9.0	—	Medium to rapid	.37	2	4L	Low	D	Grazing, wildlife habitat, recreation
				Torrifluvents 10% Others 10%																								
F3	Torriorthents-Rock outcrop association	1	Torriorthents		45	Fine-loamy	Uplands	2–30	5,200–7,200	>47	90–120	Shrubs and grass	>60	Well	Loam	Loam	Moderate	High	Moderate	7.4–8.4	0–4	Medium to rapid	.28	5	6	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Rock outcrop		25	—	Uplands	—	—	—	—	Barren	—	—	—	—	—	—	—	—	—	Rapid	—	—	—	—	D	Recreation
				Haplargids 10% Torrifluvents 10% Others 10%																								
F4	Haplargids-Torriorthents association	5	Haplargids		35	Fine-loamy	Uplands	3–20	5,200–7,200	>47	120–140	Shrubs and grass	20–40	Well	Sandy loam	Sandy clay loam	Moderate	Low to Moderate	Moderate	6.6–8.4	—	Medium to rapid	.24	3	3	Low	C	Grazing, wildlife habitat, irrigated hay and pasture, recreation
			Torriorthents		25	Fine-loamy	Uplands	1–20	5,200–7,200	>47	120–140	Shrubs and grass	>60	Well	Clay loam	Clay loam	Moderately slow	Moderate to high	Moderate	7.4–9.0	—	Medium to rapid	.37	5	6	Low	C	
				Camborthids 15% Others 15% Rock outcrop 10%																								
F9	Haplargids association	7	Haplargids		50	Fine-loamy	Alluvial fans and high terraces	0–20	6,250–7,200	47	120–140	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Moderate	Moderate	6.6–8.4	—	Slow to rapid	.32	5	6	Low	B	Grazing, wildlife habitat, irrigated hay and pasture, recreation
				Torriorthents 20% Torripsamments 20% Others 10%																								
M1	Haplargids-Torrifluvents-Torriorthents association	10	Haplargids		30	Garland	Terraces and alluvial fans	0–6	3,800–5,200	50–52	120–140	Shrubs and grass	>60	Well	Loam	Clay loam	Moderate	Low to moderate	Moderate	7.4–8.4	—	Slow to medium	.32	5	6	Low	B	Irrigated cropland, grazing, wildlife habitat, recreation
			Torrifluvents		25	Youngston	Low terraces and alluvial fans	0–10	3,800–5,200	50–52	120–140	Shrubs and grass	>60	Well	Clay loam	Clay loam	Moderately slow	High	Moderate	7.4–8.4	—	Slow to medium	.37	5	4L	Low	C	
			Torriorthents		20	Apron	Alluvial fans	2–12	3,800–5,200	50–52	120–140	Shrubs and grass	>60	Well	Sandy loam	Sandy loam	Moderately rapid	Moderate	Low	7.4–8.4	—	Slow to medium	.20	5	3	Low	B	
				Fluvaquents 10% Others 15%																								
M2	Torriorthents-Camborthids association	11	Torriorthents		60	Greybull	Uplands	0–30	3,800–5,200	50–52	120–140	Shrubs and grass	20–40	Well	Clay loam	Clay loam	Moderately slow	Low to Moderate	Moderate	7.4–8.4	—	Slow to rapid	.37	3	4L	Low	C	Irrigated cropland, grazing, wildlife habitat, recreation
			Camborthids		25	Pavillion	Uplands	2–20	3,800–5,200	50–52	120–140	Shrubs and grass	20–40	Well	Clay loam	Clay loam	Moderately slow	Low to Moderate	Moderate	7.4–8.4	—	Slow to rapid	.37	3	4L	Low	C	
				Haplargids 10% Others 5%																								
M3	Haplargids-Natrargids-Torriorthents association	16	Haplargids		25	Saddle	Uplands	0–20	3,800–5,200	50–52	120–140	Shrubs and grass	20–40	Well	Sandy loam	Sandy clay loam	Moderate	Low to Moderate	Moderate	6.6–9.0	—	Slow to rapid	.24	3	3	Low	C	Irrigated cropland, grazing, wildlife habitat, recreation
			Natrargids		15	Meeteetse	Alluvial fans	1–12	3,800–5,200	50–52	120–140	Shrubs and grass	40–60	Well	Loam	Clay	Very slow	Low	High	8.5–>9.0	0–15	Rapid	.43	4	4L	Low	D	Grazing, wildlife habitat, recreation
			Torriorthents		40	Persayo	Uplands	2–45	3,800–5,200	50–52	120–140	Shrubs and grass	10–20	Well	Clay loam	Clay loam	Moderately slow	Low	Moderate	7.4–9.0	—	Slow to rapid	.37	2	4L	Low	D	Grazing, wildlife habitat, recreation
				Torrifluvents 10% Others 10%																								
M4	Camborthids-Torriorthents association	3	Camborthids		20	Gystrum	Uplands	2–20	4,500–5,200	50–52	120–140	Shrubs and grass	20–40	Well	Silty clay loam	Silty clay loam	Moderate	Low	Moderate	7.4–8.4	2–15	Rapid	.37	3	4L	Moderate	C	Grazing, wildlife habitat, recreation
			Torriorthents		50	Neville	Alluvial fans	2–30	4,500–5,200	50–52	120–140	Shrubs and grass	>60	Well	Loam	Loam	Moderate	High	Moderate	7.4–8.4	0–4	Medium to rapid	.32	5	4L	Low	C	Grazing, wildlife habitat, irrigated cropland, recreation
				Rock outcrop 15% Others 15%																								

1/ Slope range in this table applies to the total range in slope for the appropriate dominant soil.

LEGEND

SOILS OF THE MOUNTAINS, MOUNTAIN VALLEYS AND MOUNTAIN FOOTHILLS

C-1 Cryoborolls-Cryoborolls-Rock outcrop association: steep and very steep, shallow and moderately deep, well-drained soils and rock outcrops on tops and sides of mountains.

C-2 Cryoborolls-Rock outcrop association: steep and very steep, shallow to deep, well-drained soils on sides and foothills of mountains.

C-3 Cryoborolls-Rock outcrop association: steep, shallow to deep, well-drained soils on dissected mountain fronts and rounded knolls and ridges of mountains.

SOILS OF THE MOUNTAIN FOOTHILLS AND DESERTIC BASINS

F-1 Haplargids-Argiborolls association: nearly level to steep, deep, well-drained soils on terraces, fans and till plains of the mountain foothills.

F-2 Haplargids-Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected mountain foothills and on uplands in desertic basins.

F-3 Torriorthents-Rock outcrop association: rolling and steep, shallow to deep, well-drained soils on mountain foot slopes.

F-4 Haplargids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on mountain foothills and on uplands in desertic basins.

Ustorthents-Argiborolls-Haploborolls association: nearly level to very steep, shallow to deep, well-drained soils on mountain foothills.

Haplargids association: nearly level to rolling, deep, well-drained soils on terraces and uplands of desertic basins.

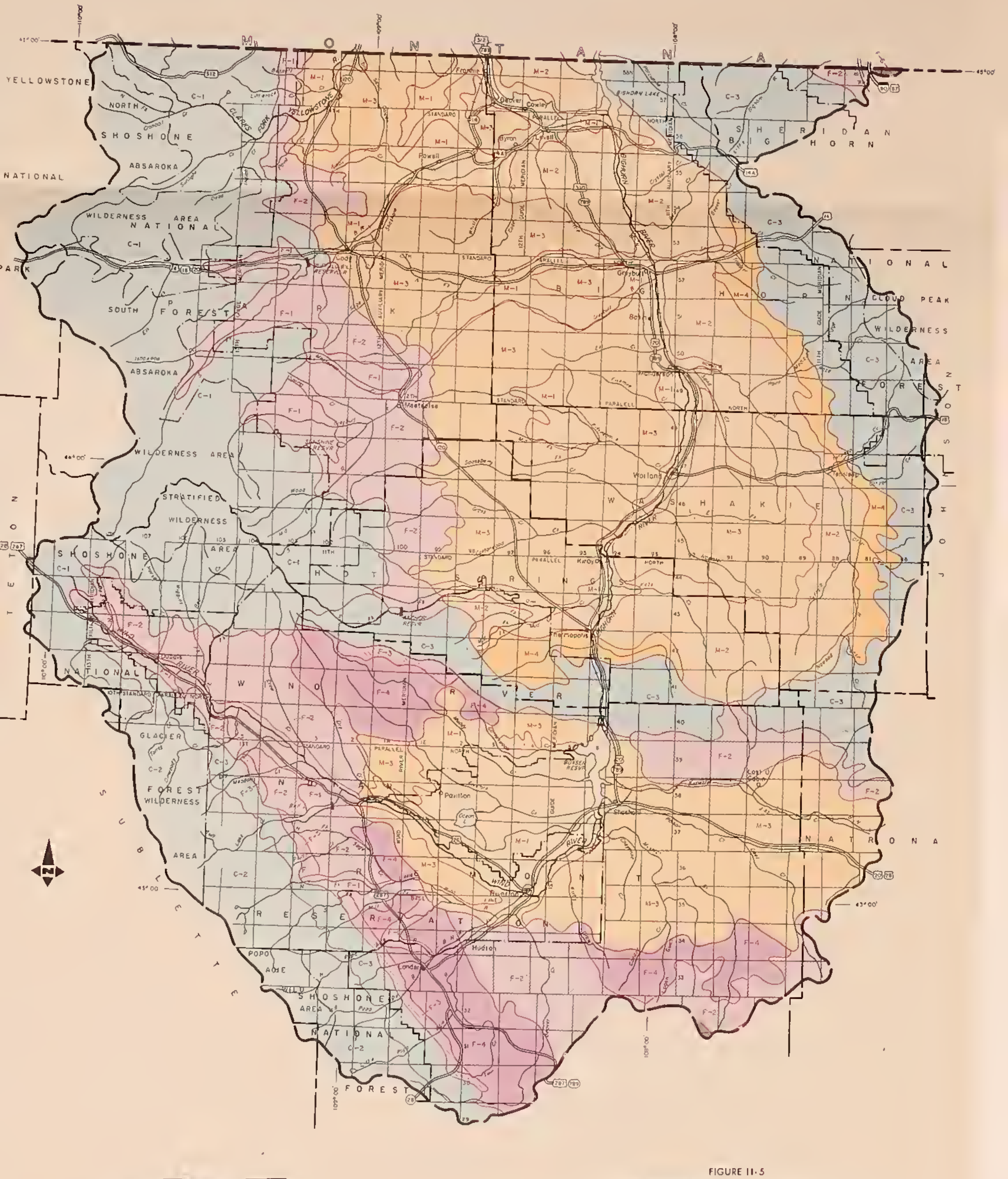
SOILS OF DESERTIC BASINS AND UPLANDS

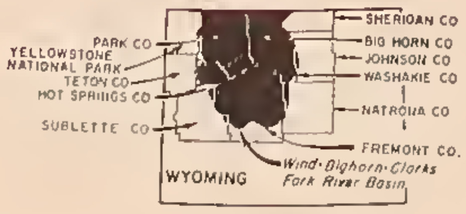
M-1 Haplargids-Torrifluvents-Torriorthents association: nearly level to sloping, deep, well-drained soils on terraces and fans of desertic basins.

M-2 Torriorthents-Camborthids association: nearly level to steep, shallow to deep, well-drained soils on uplands of desertic basins.

M-3 Haplargids-Natrargids-Torriorthents association: undulating to steep, shallow to deep, well-drained soils in desertic basins and on uplands.

M-4 Camborthids-Torriorthents association: rolling and steep, shallow to deep, well-drained soils on dissected uplands in desertic basins.





LOCATION MAP

FIGURE II-5

GENERALIZED SOIL MAP

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

in material weathered from interbedded sandstone and shale on rolling to dissected and rough, broken uplands. There are some deep to shallow, well drained, moderately to strongly alkaline loamy soils which formed in materials weathered from red beds and thin interbedded sandstone and limestone on rolling to steep, dissected uplands; deep, excessively drained, light colored sandy soils which formed in deep, loose sands on gently sloping to dune-like uplands; and deep, well to poorly drained, light colored loamy soils which formed in alluvium on floodplains and stream terraces. These soils are moderately to strongly alkaline, and some are moderately to strongly saline.

The Northern Rocky Mountain LRA, which comprises about 27 percent of the total basin area, is largely public land with heavy forest cover. Elevations range from 6,000 to 12,000 feet. The average annual precipitation is 20 to 70 inches. Most of the soils are shallow to deep, well drained, dark colored, loamy soils. They formed in material weathered from volcanic rocks, granite, gneiss, and schist. There are many rock outcrops. In the narrow valleys the soils are deep, well to poorly drained, dark colored, gravelly, cobbly, and stony on narrow flood plains, stream terraces, and alluvial fans.

The Alpine Meadows and Rockland LRA, which comprises about 3 percent of the total basin area, is mostly public land covered with alpine grasses, herbaceous plants, and shrubs. Elevations are 10,000 feet or more. The average annual precipitation is 20 to 70 inches. The soils are shallow to deep, well drained, dark colored, loamy soils. Fifty percent or more of the area is rock outcrop.

The Northern Rocky Mountain Foothills LRA comprises about 13 percent of the total basin area. Some of the alluvial soils in the small valleys are irrigated and are used to produce grain and forage for livestock, but the area is used mainly for grazing. The vegetation is mainly short and mid-grasses and shrubs. Some of the highest areas are in forest. Elevations range from 5,000 to 7,500 feet. The annual precipitation is 12 to 20 inches. Included are: Deep, well to poorly drained, dark colored, loamy soils which formed in alluvium on flood plains, stream terraces, and alluvial fans; deep, well drained, dark colored gravelly, cobbly, and stony soils on rolling to steep glacial moraines and outwash fans and terraces; deep to shallow, well drained, light colored, loamy and clayey soils which formed in material weathered from interbedded sandstone and shale on strongly dissected, rolling to steep uplands with some rock outcrops; deep and shallow, well drained, light colored, loamy soils which formed in materials weathered from red beds, limestone, and sandy shales on rolling to steep, strongly dissected uplands with many rock outcrops.

Vegetative aspect

Vegetative aspect is a term used herein to denote a dominant type of vegetation within a mapping unit of land area. These areas are summarized in table II-5 and shown on the map of figure II-6. The vegetative aspect is dependent on elevation, soil, exposure, and rainfall, and ranges from

Table II-5--Vegetative aspects by watershed and subbasin areas

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
	Wind River Subbasin	----------	----------	----------	----------	acres	----------	----------	----------	----------
14e-1	Upper Poison Creek	140	1,610	0	0	0	0	228,820	0	230,570
14e-3	Lower Poison Creek	10	4,390	0	0	0	0	98,680	0	103,080
14e-4	Fivemile Creek	200	12,990	320	0	26,820	0	81,820	0	122,150
14e-5	Muddy Creek	620	70,630	12,970	26,050	57,320	0	76,590	0	244,180
14e-6	Dry Muddy Creek	9,000	22,100	190	2,950	16,250	0	91,730	0	142,220
14e1-1	Upper Wind River	680	3,380	2,190	98,470	270	0	19,800	19,140	143,930
14e1-1a	Horse Creek	90	6,770	2,820	37,270	920	100	43,350	13,580	104,900
14e1-2	Wiggins Fork	80	4,600	660	70,960	540	0	20,530	46,060	143,430
14e1-3	Jakeys Fork-Torrey Creek	2,060	7,790	1,510	92,650	1,260	0	35,330	47,200	187,800
14e1-4	East Fork	40	1,090	1,290	79,050	580	0	17,100	40,440	139,590
14e1-5	Crow Creek	0	19,700	2,760	8,700	32,600	0	47,150	7,100	118,010
14e1-6	Dinwoody Creek	1,950	42,220	13,040	37,750	23,000	0	58,100	69,340	245,400
14e1-7	Bull Lake	2,690	4,950	720	14,400	26,700	0	28,750	84,980	163,190
14e1-8	Crowheart Butte-Dry	0	54,410	3,490	5,500	11,930	0	93,610	0	168,940
14e1-9	Midvale	7,060	11,140	62,070	0	15,590	40	84,640	0	180,540
14e1-10	Riverton	680	1,610	25,600	0	7,320	650	89,610	0	125,470
14e1-12	Kirby Draw	0	1,510	130	0	5,860	0	118,270	0	125,770
14e1a-1	Little Popo Agie	990	7,800	8,250	54,280	1,840	0	158,980	6,490	238,630
14e1a-2	Middle Popo Agie	1,980	8,710	13,270	62,360	6,720	0	53,220	19,860	166,120
14e1a-2a	North Popo Agie	740	15,930	5,140	6,020	16,840	0	72,930	0	117,600
14e1a-3	South Lower Little Wind	0	12,100	24,710	8,990	8,540	0	55,600	0	109,940
14e1a-4	Upper Little Wind	720	13,470	4,050	10,450	47,370	0	20,240	65,690	161,990
14e1a-4a	North Lower Little Wind	0	11,970	6,140	6,740	11,370	0	121,860	1,680	159,760
14e1a-5	Upper Beaver Creek	10	16,450	940	10,670	2,990	0	149,690	0	180,750
14e1a-6	Lower Beaver Creek	0	10,620	370	0	1,370	0	81,850	0	94,210
14e2-1	Muskrat	0	11,010	0	0	0	0	235,900	0	246,910
14e2-2	Conant Creek	60	1,050	0	0	0	0	177,210	0	178,320
14e2-3	Lower Muskrat	0	280	0	0	0	0	59,630	0	59,910
14e3-1	Alkali Creek	0	7,520	0	7,520	0	0	134,440	0	149,480
14e3-2	Upper Badwater Creek	0	2,230	1,720	14,610	0	0	115,280	0	133,840
14e3-3	Bridger Creek	20	5,150	1,060	5,660	1,730	0	104,180	0	117,800
14e3-4	Lower Badwater Creek	9,070	33,560	360	15,410	750	0	129,160	0	188,310
Subtotal		38,890	428,740	195,770	676,460	326,480	790	2,904,050	421,560	4,992,740

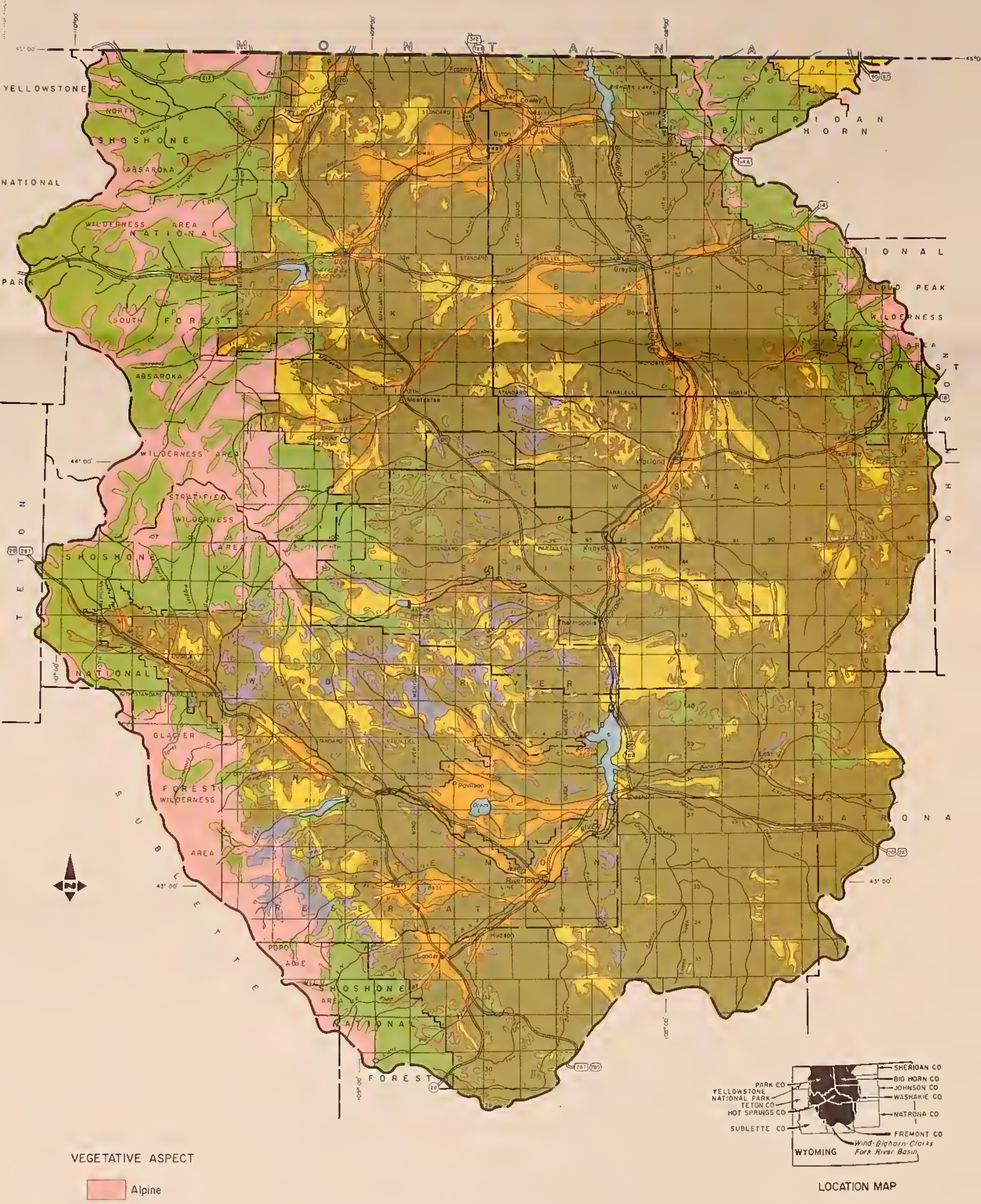
Table II-5--Vegetative aspects by watershed and subbasin areas (Continued)

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
	Bighorn River Subbasin					acres				
14e-6a	Red Canyon Creek	0	75,700	310	100	14,100	0	10,750	0	100,960
14e-7	Buffalo Creek	0	71,960	110	4,260	2,490	0	15,080	0	93,900
14e-8	Upper South Fork Owl Creek	0	44,670	0	29,040	3,890	0	3,500	0	81,100
14e-8a	Upper Owl Creek	430	83,160	12,640	18,990	27,690	0	20,790	0	163,700
14e-9	Mud Creek	0	47,910	1,310	1,280	9,660	0	18,010	0	78,170
14e-10	Candy Jack	0	0	0	540	0	170	700	0	1,410
14e-10a	East Thermopolis	0	740	0	1,230	0	0	19,720	0	21,690
14e-10b	Lucerne	0	0	4,650	1,370	0	0	18,690	0	24,710
14e-10c	Upper Hanover	0	3,330	7,950	0	0	0	26,340	0	37,620
14e-11	Kirby Creek	10	56,650	2,970	1,610	0	0	107,900	0	169,140
14e-12	No Water Creek	0	48,280	0	0	0	0	115,820	0	164,100
14e-12a	East Fork No Water Creek	0	70	0	0	0	0	100,690	0	100,760
14e-13	Gebo Mine	0	4,610	560	8,090	0	0	72,370	0	85,630
14e-14	Upper Cottonwood	0	11,890	1,160	15,870	6,110	0	90,640	0	125,670
14e-15	Gooseberry Creek	30	20,640	3,820	28,210	6,370	0	173,220	0	232,290
14e-16	Lower Cottonwood	0	650	3,000	23,480	1,830	0	147,140	0	176,100
14e-17	Colter	0	1,050	3,480	0	0	0	11,810	0	16,340
14e-17a	WA Sage	0	1,480	4,050	0	0	0	4,350	0	9,880
14e-17b	Lower Hanover	0	4,080	17,510	0	0	170	27,970	0	49,730
14e-19	Upper Fifteen Mile	0	12,250	0	1,100	2,440	0	89,810	0	105,600
14e-20	Lower Fifteen Mile	0	68,920	320	0	15,170	0	150,600	0	235,010
14e-21	Fivemile-Elk Creek	0	940	16,850	0	0	180	169,430	0	187,400
14e-22	Upper Shell Creek	220	12,830	830	60,250	0	0	94,310	0	168,440
14e-23	Lower Shell Creek	40	0	9,730	20,360	970	0	173,440	0	204,540
14e-24	Bear Creek	10	0	80	1,260	0	0	72,280	0	73,630
14e-24a	Crystal Creek	5,000	2,090	1,730	19,840	390	0	86,130	0	115,180
14e-25	Dry Creek	150	34,840	2,020	0	0	0	209,900	0	246,910
14e-26	Little Dry Creek	0	180	520	0	0	0	104,800	0	105,500
14e-27	Crooked Creek	0	420	1,080	2,960	0	0	16,220	0	20,680
14e-28	Porcupine Creek	3,650	12,820	330	38,940	0	0	41,880	0	97,620
14e4-1	Upper Nowood	30	16,720	2,580	5,910	230	0	208,020	0	233,490
14e4-2	Buffalo Creek	0	11,870	80	0	0	0	101,010	0	112,960
14e4-3	Middle Nowood	0	11,920	2,680	0	10,840	0	157,230	0	182,670
14e4-4	Tensleep Creek	540	1,640	1,880	70,320	580	30	68,750	23,690	167,430
14e4-5	Bonanza	100	12,020	3,690	17,980	0	0	147,050	0	180,840

Table II-5--Vegetative aspects by watershed and subbasin areas (Continued)

Watershed Number	Watershed Name	Water	Grass	Cropland	Trees	Barren	Urban	Brush	Alpine	Total
		acres								
	Bighorn River Subbasin (Continued)									
14e4-6	Paintrock Creek	790	7,920	5,880	81,720	690	50	125,950	22,000	245,000
14e4-7	Lower Nowood	10	26,200	3,740	0	0	80	178,950	0	208,980
14e5-1	Wood River	1,200	80,930	6,880	53,500	5,660	0	35,300	0	183,470
14e5-2	Upper Greybull	10	89,270	780	60,570	7,580	0	24,350	0	182,560
14e5-3	Meeteetse	0	44,340	10,760	5,100	0	50	152,670	0	212,920
14e5-4	Lower Greybull	130	39,040	45,230	0	0	340	118,190	0	202,930
14e6-1	Shoshone Plateau	20	43,340	0	28,340	27,720	0	11,930	0	111,350
14e6-2	Upper South Fork Shoshone	0	66,270	1,620	77,150	22,080	0	21,600	0	188,720
14e6-3	Lower South Fork Shoshone	3,940	45,560	22,020	25,930	2,090	380	134,890	0	234,810
14e6-5	Whistle Creek	0	2,900	14,800	0	0	0	120,480	0	138,180
14e6-6	Heart Mountain-Powell	230	39,780	67,950	9,300	0	830	131,850	0	249,940
14e6-7	Lovell-Kane	200	4,120	15,400	0	0	420	143,260	0	163,400
14e6-8	Sage Creek-Pryor Mountain	0	2,990	23,510	0	0	630	73,630	0	100,760
14e6-8a	North Lovell-Dry Creek	8,650	760	1,030	6,980	0	0	35,840	0	53,260
14e6a-1	Sylvan Pass	30	92,600	0	115,970	13,260	0	13,950	0	235,810
14e6a-2	Wapiti	1,520	39,820	1,240	54,700	17,820	0	29,030	0	144,130
14e6a-2a	Trout Creek	1,540	60,040	740	59,000	16,410	0	31,310	0	169,040
Subtotal		28,480	1,362,210	329,500	951,250	216,070	3,330	4,259,530	45,690	7,196,060
	Clarks Fork River Subbasin									
14c-1	Sunlight Basin	50	51,410	970	64,780	21,010	0	9,690	0	147,910
14c-2	Crandell Creek	10	39,850	300	61,470	10,700	0	5,310	0	117,640
14c-3	Clarks Fork	1,530	33,000	650	74,140	16,450	0	14,250	0	140,020
14c-4	Pat O'Hara	90	35,570	5,770	20,020	1,530	0	67,770	0	130,750
14c-4a	Big Sand Coulee	0	20,690	400	0	0	0	65,490	0	86,580
14c-5	Cyclone Bar	1,200	61,820	3,030	14,350	8,770	0	23,930	0	113,100
14c-6	Elk Basin	0	6,630	0	0	0	0	44,570	0	51,200
14c-7	Clarks Fork-Ruby Creek	(Included in 5)								
14c-8	Upper Rock Creek	0	6,270	0	550	2,180	0	370	0	9,370
Subtotal		2,880	255,240	11,120	235,310	60,640	0	231,380	0	796,570
	Little Bighorn River Subbasin									
14e7-1	Little Bighorn River	40	5,530	260*	87,160	2,850	0	27,590	90	123,520
14e7-2	Pass Creek	10	30,180	6,250*	11,830	100	10	4,910	1,110	54,400
14e7-3	Lodge Grass Creek	0	0	0	8,870	0	0	6,080	0	14,950
14e7-4	Owl Creek	0	800	0	0	0	0	0	0	800
Subtotal		50	36,510	6,510	107,860	2,950	10	38,580	1,200	193,670
Grand Total		70,300	2,082,700	542,900	1,970,880	606,140	4,130	7,433,540	468,450	13,179,040

* 100 acres dry cropland in 14e7-1; 3,970 acres dry cropland in 14e7-2. 4,070 acres included in grand total.



VEGETATIVE ASPECT

- Alpine
- Barren
- Brush
- Crop
- Grass
- Trees
- Water

FIGURE II-6

VEGETATIVE ASPECT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

alpine in higher elevations to timber at mid-elevations to barren desert on the basin floor.

The grass aspect includes short and intermediate grasses which cover about 16 percent of the basin. It is used for cattle, sheep, and wildlife grazing.

Range conditions on grasslands are about 16 percent excellent, 56 percent good, 24 percent fair, and 4 percent poor.

Trees are the predominant vegetation on about 1,971,000 acres or about 15 percent of the basin's area. Curiously, trees are not always required for an area to be classified as forest land. 1/ Capability is the key word, and because of this, about one-fifth of the basin, or 2,301,700 acres, is classed as forest land. The ownership of forest land is shown in table II-6. For quick reference it breaks out at about 76 percent federal, 9 percent Indian, and 15 percent state and other private forests.

About 1,128,000 acres of forest are classed as noncommercial. 2/ This includes the six National Forest Wilderness and Primitive Areas, and Yellowstone National Park lands. Table II-6 will show you the area of forest land by ownership and type of forest. In table II-7 you can find the areas of forest land by ownership in each subbasin. Figure II-8 lists areas of commercial and noncommercial forest by size of timber and ownership.

Barren and brushlands are in the lower elevations on the basin floor. Most of these lands are administered by the Bureau of Land Management and are used for cattle, sheep, and wildlife grazing. Production is limited by the low rainfall. Range conditions on brushlands are 19 percent excellent, 54 percent good, 23 percent fair, and 4 percent poor.

Alpine lands are found in the higher elevations above the timber line. They are used primarily for wildlife habitat and summer range for cattle and sheep.

Nearly all the cropland in the basin is irrigated. Irrigated lands have been inventoried by types. A summary of the inventory is shown in

---

1/ As used in this report, forest land is land at least 10 percent stocked by trees of any size and capable of producing timber or other wood products or of exerting significant influence on climate and water regimes. However, land from which trees have been removed to less than 10 percent stocking, and which have not been developed for other uses, are still defined as forest lands.

2/ Commercial forest land is land which is producing or is capable of producing an economically usable harvest of wood (usually at least 20 cubic feet per acre annually) and is not withdrawn or reserved from cutting.

Table II-6 --Area of forest land by major forest type and ownership

Forest type	National Forest	Other public domain	Wind River Indian Reservation	Yellowstone National Park	State and private a/
	----------	----------	thousand acres	----------	----------
Lodgepole pine	398.3	6.5	18.6	2/	40.0
Spruce-fir	187.2	2.1	12.5	2/	3.9
Douglas-fir	196.7	8.3	3.8	2/	67.0
Ponderosa pine	7.1	2.0	--	2/	5.9
Aspen-cottonwoods	16.9	0	0.1	2/	12.0
Whitebark-limber pine	114.0	0.3	3.1	2/	67.3
Noncommerical 2/	795.8	1.0	169.0	18.2	144.2
Total	1,716.0	20.2	207.0	18.2	340.3

a/ Estimates of forest types on private land are based on the distributions reported for state lands.

b/ Forest type distribution was not available for noncommercial land.

in table II-9. Type I are lands used for producing beans, corn, beets, potatoes, small grains, hay, pasture, and other crops. Production yields are high, water supply is adequate, and irrigation systems are generally in good condition. Type II are lands which are primarily used to produce hay and pasture. Irrigation systems are not very elaborate; land preparation, cultivation, and crop rotation are limited. Crop yields are limited by either climate, water supply, or management. Type III lands, commonly referred to as mountain meadows, are used primarily to produce native hay and pasture. Type IV lands are used to produce perennial crops which can survive for long periods without irrigation. Lands irrigated by water-spreading systems are included. Production inputs, including irrigation, are minimal. Type V lands receive water only incidentally as a result of the irrigation of other lands. The vegetation is mainly native grass used for hay and pasture. While not shown by type of irrigation, the location of major irrigated and irrigable lands is shown in figure II-7. More information is given about irrigated and irrigable lands in chapter VII.

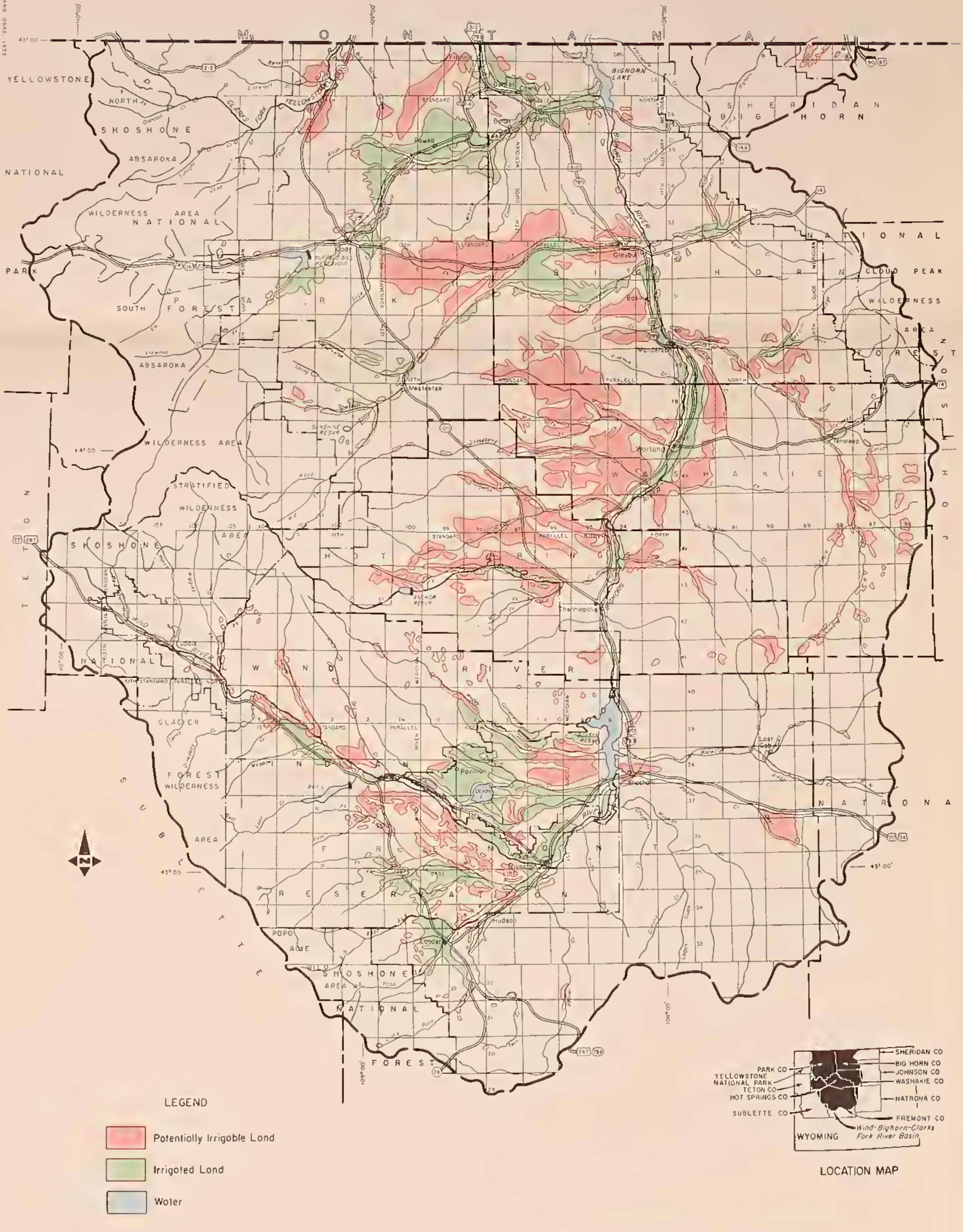


FIGURE II-7

IRRIGABLE AND IRRIGATED LAND

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

7-N-22780E

Table II-7--Area of forest land by ownership and subbasin

Ownership	Total	Wind River	Bighorn River	Clarks Fork River	Little Bighorn River
	-----	-----	thousand acres	-----	-----
National Forest	1,716.0	474.4	910.0	237.4	94.2
Public Domain	20.2	8.0	12.2	0	0
Yellowstone National Park	18.2	0	18.2	0	0
Wind River Indian Reservation	207.0	207.0	0	0	0
State and private	340.3	251.9	74.4	8.1	5.9
Total	2,301.7	941.3	1,014.8	245.5	100.1

SURFACE WATER RESOURCES

There are about 70,300 surface acres of lakes, ponds, and reservoirs and 6,500 miles of creeks, streams, and rivers in the basin. Table II-10 lists these by subbasin.

The median annual volume of water leaving the State of Wyoming from the Clarks Fork, Bighorn, and Little Bighorn Rivers is approximately 3,230,800 acre-feet. In addition it is estimated that approximately 1,037,100 acre-feet of water are consumed in the production of irrigated crops. The sum of these two amounts (4,267,900 acre-feet) is an estimate of the total surface water supply available for at least half of the water years 1/ of record (50 percent chance). This yield is equivalent to about 3.9 inches of water from the entire basin area. The average annual yield per acre, however, varies from less than 0.1 inches from some low elevation areas to more than 50 inches in some mountainous areas. For example, the Shoshone River above Buffalo Bill Dam, with more than half of this area above 8,000 feet, yields an average 13.32 inches per year while Badwater Creek, with only 3 percent of its area above 8,000 feet, averages about 0.2 inches of runoff per year. For the 8 years of record on Muskrat Creek near Shoshoni, runoff averaged less than 0.02 inches. Some of the lower elevation lands yield surface water only periodically while streams and rivers originating in the mountainous areas flow all year long.

Table II-11 is a surface water budget showing estimated total water supplies and major depletions by hydrologic subareas in the basin. These data were obtained through analysis of stream gaging records supplemented by a river basin simulation model. Irrigation and phreatophyte depletion estimates are based on field and aerial photograph surveys of area and the

1/ A water year begins on October 1 of each calendar year and ends on September 30.

Table II-8--Commercial and noncommercial forest land area by stand size class and ownership, 1971

Stand size class	Ownership					
	All	National Forest	Public domain	Wind River Indian Res.	Yellowstone Nat. Park	State and private
	thousand acres					
Commercial forest						
Sawtimber	719.9	475.2	15.6	33.0	0	196.1
Poletimber	364.5	361.0	3.5	1/	0	0
Seedlings and saplings	66.1	61.0	0.1	5.0	0	0
Nonstocked	23.0	23.0	0	0	0	0
Subtotal commercial forest	1,173.5	920.2	19.2	38.0	0	196.1
Noncommercial and reserved forest 2/	1,128.2	795.8	1.0	169.0	18.2	144.2
Total forest land	2,301.7	1,716.0	20.2	207.0	18.2	340.3

1/ Poletimber area included with sawtimber.

2/ Stand size class not available for noncommercial and reserved forest land.

PLATE 5

Water resources of the basin depend on the melting of the high country snowpack. Much of the basin presently has abundant, good quality water. U.S. FOREST SERVICE PHOTO

In some locations, the Madison Flathead formations are capable of producing large flows. This is an artesian well with over 200 pounds per square inch of pressure.

This artesian well provides water for sprinkler irrigation.

PLATE 6

Table II-9--Irrigated lands by type of irrigation, 1970

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
	Wind River Subbasin	----	----	----	acres	----	----
14e-1	Upper Poison Creek	0	0	0	0	0	0
14e-3	Lower Poison Creek	0	0	0	0	0	0
14e-4	Fivemile Creek	0	0	0	320	0	320
14e-5	Muddy Creek	9,570	2,180	0	1,120	100	12,970
14e-6	Dry Muddy Creek	0	0	0	190	0	190
14e1-1	Upper Wind River	0	0	1,960	230	0	2,190
14e1-1a	Horse Creek	0	2,350	350	20	100	2,820
14e1-2	Wiggins Fork	0	660	0	0	0	660
14e1-3	Jakeys Fork-Torrey Creek	0	1,140	130	240	0	1,510
14e1-4	East Fork	0	830	80	240	140	1,290
14e1-5	Crow Creek	0	2,110	0	220	430	2,760
14e1-6	Dinwoody Creek	0	11,150	20	350	1,520	13,040
14e1-7	Bull Lake	0	680	0	0	40	720
14e1-8	Crowheart Butte-Dry Creek	0	2,630	0	420	440	3,490
14e1-9	Midvale	43,410	14,590	0	80	3,990	62,070
14e1-10	Riverton	18,250	4,080	0	70	3,200	25,600
14e1-12	Kirby Draw	0	130	0	0	0	130
14e1a-1	Little Popo Agie	0	6,190	760	10	1,290	8,250
14e1a-2	Middle Popo Agie	0	11,070	1,050	150	1,000	13,270
14e1a-2a	North Popo Agie	0	4,240	330	20	550	5,140
14e1a-3	South Lower Little Wind	200	18,170	280	1,780	4,280	24,710
14e1a-4	Upper Little Wind	0	2,560	110	480	900	4,050
14e1a-4a	North Lower Little Wind	1,730	3,360	0	610	440	6,140
14e1a-5	Upper Beaver Creek	0	680	70	190	0	940
14e1a-6	Lower Beaver Creek	0	280	0	10	80	370
14e2-1	Muskrat	0	0	0	0	0	0
14e2-2	Conant Creek	0	0	0	0	0	0
14e2-3	Lower Muskrat	0	0	0	0	0	0
14e3-1	Alkali Creek	0	0	0	0	0	0
14e3-2	Upper Badwater Creek	0	1,040	370	240	70	1,720
14e3-3	Bridger Creek	0	820	150	90	0	1,060
14e3-4	Lower Badwater Creek	0	120	0	240	0	360
	Subtotal	73,160	91,050	5,660	7,320	18,570	195,770

Table II-9--Irrigated lands by type of irrigation, 1970 (Continued)

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
	Bighorn River Subbasin	acres					
14e-6a	Red Canyon Creek	0	310	0	0	0	310
14e-7	Buffalo Creek	0	110	0	0	0	110
14e-8	Upper South Fork Owl Creek	0	0	0	0	0	0
14e-8a	Upper Owl Creek	0	10,160	80	2,300	100	12,640
14e-9	Mud Creek	0	920	0	390	0	1,310
14e-10	Candy Jack	0	0	0	0	0	0
14e-10a	East Thermopolis	0	0	0	0	0	0
14e-10b	Lucerne	1,050	3,360	0	40	200	4,650
14e-10c	Upper Hanover	6,260	1,620	0	20	50	7,950
14e-11	Kirby Creek	0	2,300	0	620	50	2,970
14e-12	No Water Creek	0	0	0	0	0	0
14e-12a	East Fork No Water Creek	0	0	0	0	0	0
14e-13	Gebo Mine	0	540	0	20	0	560
14e-14	Upper Cottonwood	0	1,120	30	10	0	1,160
14e-15	Gooseberry Creek	0	1,600	30	2,180	10	3,820
14e-16	Lower Cottonwood	780	1,870	0	340	10	3,000
14e-17	Colter	2,990	270	0	210	10	3,480
14e-17a	WA Sage	3,290	700	0	40	20	4,050
14e-17b	Lower Hanover	14,340	2,780	0	50	340	17,510
14e-19	Upper Fifteenmile	0	0	0	0	0	0
14e-20	Lower Fifteenmile	270	30	0	20	0	320
14e-21	Fivemile-Elk Creek	11,920	4,050	0	230	650	16,850
14e-22	Upper Shell Creek	0	810	10	10	0	830
14e-23	Lower Shell Creek	1,700	7,380	60	380	210	9,730
14e-24	Bear Creek	0	80	0	0	0	80
14e-24a	Crystal Creek	700	1,000	0	0	30	1,730
14e-25	Dry Creek	790	1,060	0	80	90	2,020
14e-26	Little Dry Creek	290	210	0	0	20	520
14e-27	Crooked Creek	0	700	0	370	10	1,080
14e-28	Porcupine Creek	0	330	0	0	0	330
14e4-1	Upper Nowood	0	1,420	380	780	0	2,580
14e4-2	Buffalo Creek	0	80	0	0	0	80
14e4-3	Middle Nowood	0	2,510	90	20	60	2,680
14e4-4	Tensleep Creek	0	1,800	30	40	10	1,880
14e4-5	Bonanza	0	2,730	280	430	250	3,690

Table II-9--Irrigated lands by type of irrigation, 1970 (Continued)

Watershed Number	Watershed name	Type of irrigation I	II	III	IV	V	Total
		acres					
	Bighorn R. Subbasin (Cont'd)						
14e4-6	Paintrock Creek	0	5,390	370	30	90	5,880
14e4-7	Lower Nowood	350	3,140	0	150	100	3,740
14e5-1	Wood River	0	5,640	460	530	250	6,880
14e5-2	Upper Greybull	0	630	20	100	30	780
14e5-3	Meeteetse	200	9,800	30	280	450	10,760
14e5-4	Lower Greybull	20,000	22,690	0	510	2,030	45,230
14e6-1	Shoshone Plateau						0
14e6-2	Upper South Fork Shoshone	0	780	840	0	0	1,620
14e6-3	Lower " " "	1,970	18,090	90	1,740	130	22,020
14e6-5	Whistle Creek	11,270	3,390	0	80	60	14,800
14e6-6	Heart Mountain-Powell	56,730	10,370	0	320	530	67,950
14e6-7	Lovell-Kane	11,570	3,600	0	180	50	15,400
14e6-8	Sage Creek-Pryor Mountain	9,100	13,180	0	720	510	23,510
14e6-8a	North Lovell-Dry Creek	150	480	0	400	0	1,030
14e6a-1	Sylvan Pass						0
14e6a-2	Wapiti	0	1,220	0	0	20	1,240
14e6a-2a	Trout Creek	0	650	0	50	40	740
	Subtotal	155,720	150,900	2,800	13,670	6,410	329,500
	Clarks Fork Subbasin						
14c-1	Sunlight Basin	0	160	810	0	0	970
14c-2	Crandell Creek	0	0	230	70	0	300
14c-3	Clarks Fork	0	0	650	0	0	650
14c-4	Pat O'Hara	2,030	3,070	270	0	0	5,370
14c-4a	Big Sand Coulee	0	400	0	0	0	400
14c-5	Cyclone Bar	540	1,450	0	1,040	0	3,030
14c-6	Elk Basin	0	0	0	0	0	0
14c-7	Clarks Fork-Ruby Creek	130	270	0	0	0	400
14c-8	Upper Rock Creek	0	0	0	0	0	0
	Subtotal	2,700	5,350	1,960	1,110	0	11,120
	Little Bighorn Subbasin						
14e7-1	Little Bighorn River	0	90	0	70	0	160
14e7-2	Pass Creek	0	1,100	800	380	0	2,280
14e7-3	Lodge Grass Creek	0	0	0	0	0	0
14e7-4	Owl Creek	0	0	0	0	0	0
	Subtotal	0	1,190	800	450	0	2,440
	Total	231,580	248,500	11,220	22,550	24,980	538,830

Table II-10--Water surface area by subbasin[1/]

Subbasin	Surface acres of lakes, ponds, and reservoirs	Miles of creeks, streams, and rivers
Wind River	38,890	1,500
Bighorn River	28,480	4,300
Clarks Fork River	2,880	600
Little Bighorn River	50	100
Total	70,300	6,500

1/ Including waters which do not provide a fishery.

Blaney-Criddle method of estimating consumptive use. Supporting data are on file with the Soil Conservation Service. Figure II-8 is a map developed in this study to show annual water yield in the basin.

Approximately 50 percent of the runoff from the basin is produced during the 4-month period from April through July. This period coincides with the melting of the mountain snowpacks and the occurrence of the general spring rains. The monthly distribution of Shell Creek flows as shown in figure II-9 is typical of the unregulated mountain drainages within the basin. About 72 percent of the annual runoff from this area comes during the April to July period. Figure II-10 is a generalized surface water flow chart for the basin.

GROUND-WATER RESOURCES

The availability of ground water within favorable drilling depths varies widely throughout the basin. In areas where ground water of suitable quality and in sufficient quantity can be obtained with a reasonable drilling depth, it may be used for domestic, municipal, industrial, irrigation, or stockwater.

Ground water along the flanks of the mountains is under artesian pressure, and flowing wells may be obtained where topographic and recharge factors are favorable. Well depths and yields vary greatly. The shales are usually not aquifers, while the sandstones are capable of supplying moderate yields of from 125 to about 300 gallons per minute (GPM). The madison limestone and flathead quartzite are capable of producing large amounts of water where they are cavernous or fractured. However, these

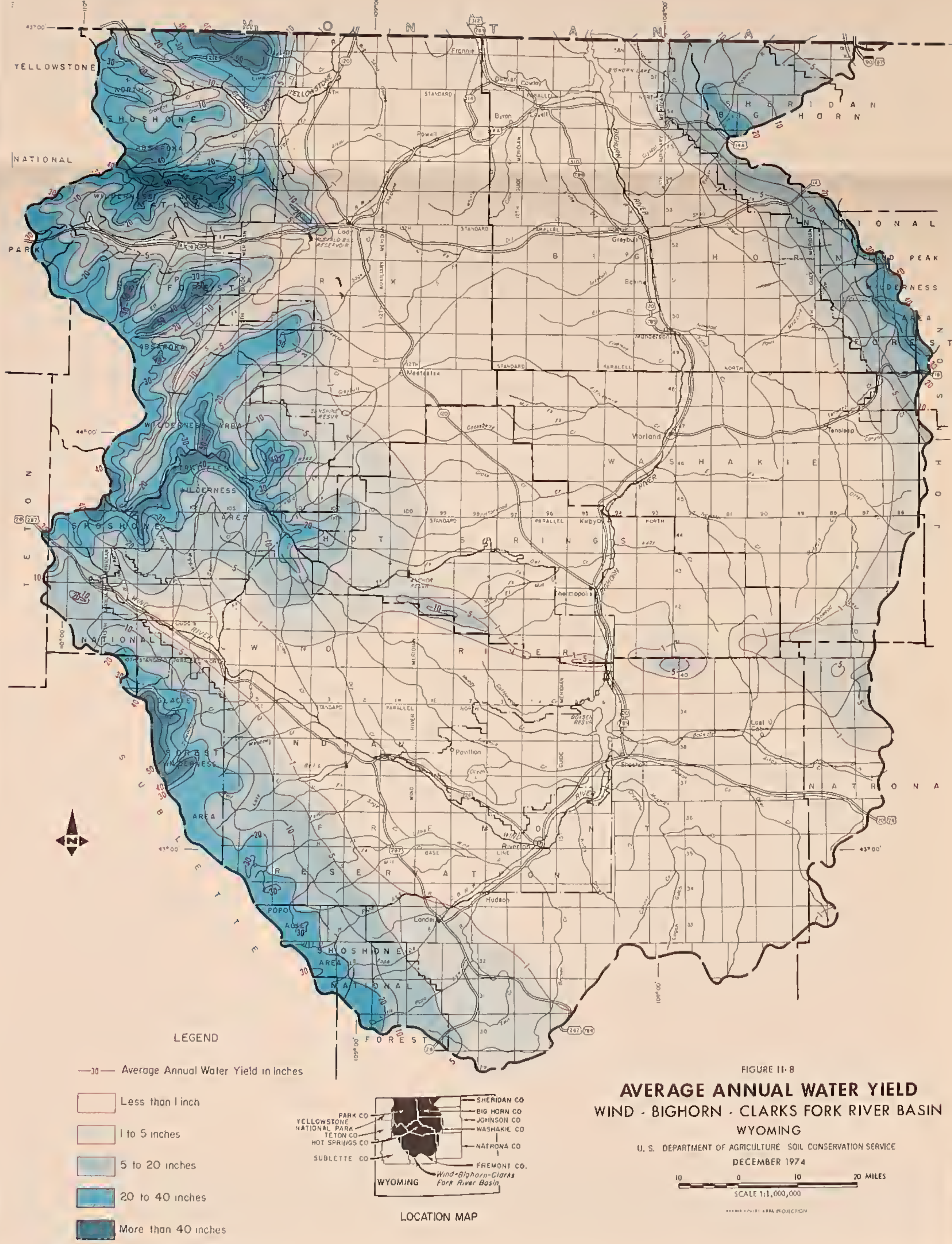


FIGURE II-8

AVERAGE ANNUAL WATER YIELD

WIND - BIGHORN - CLARKS FORK RIVER BASIN

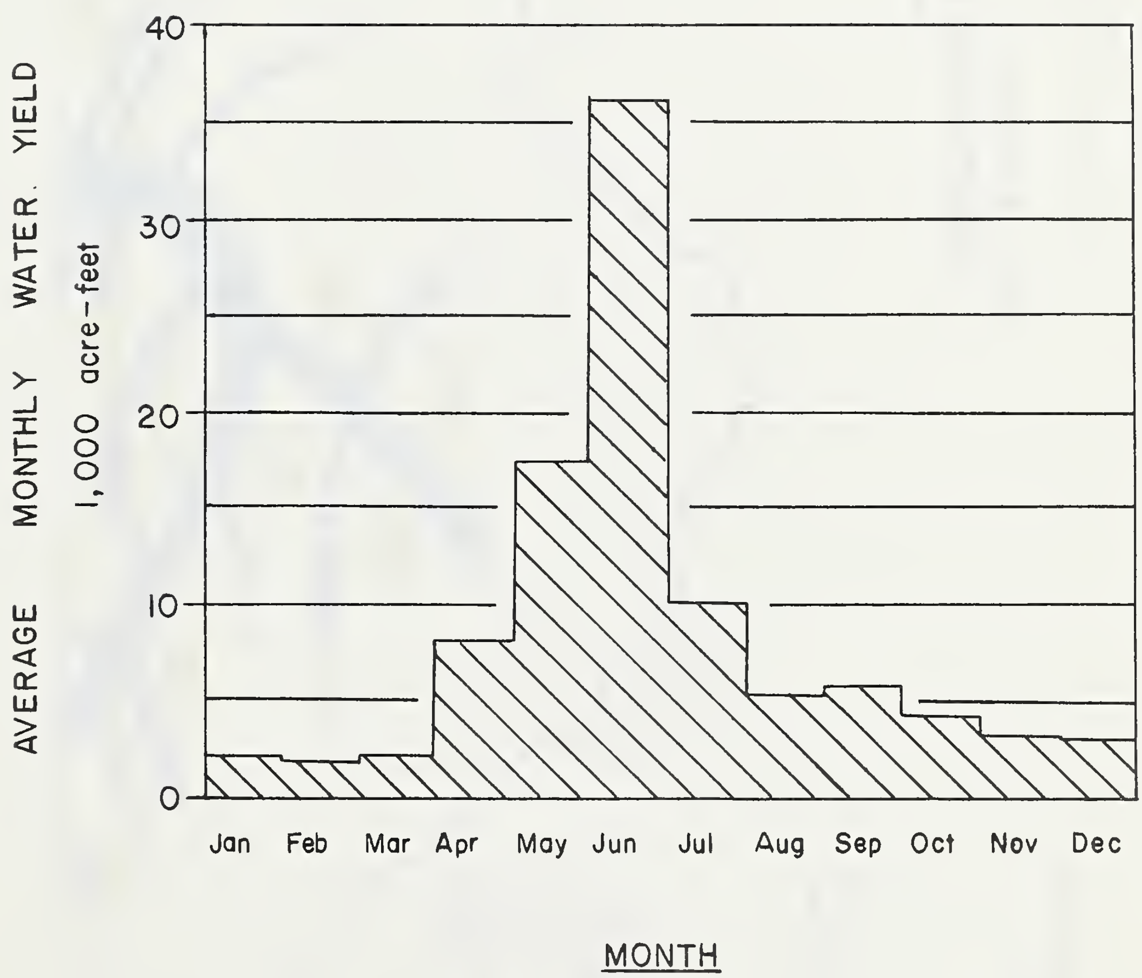
WYOMING

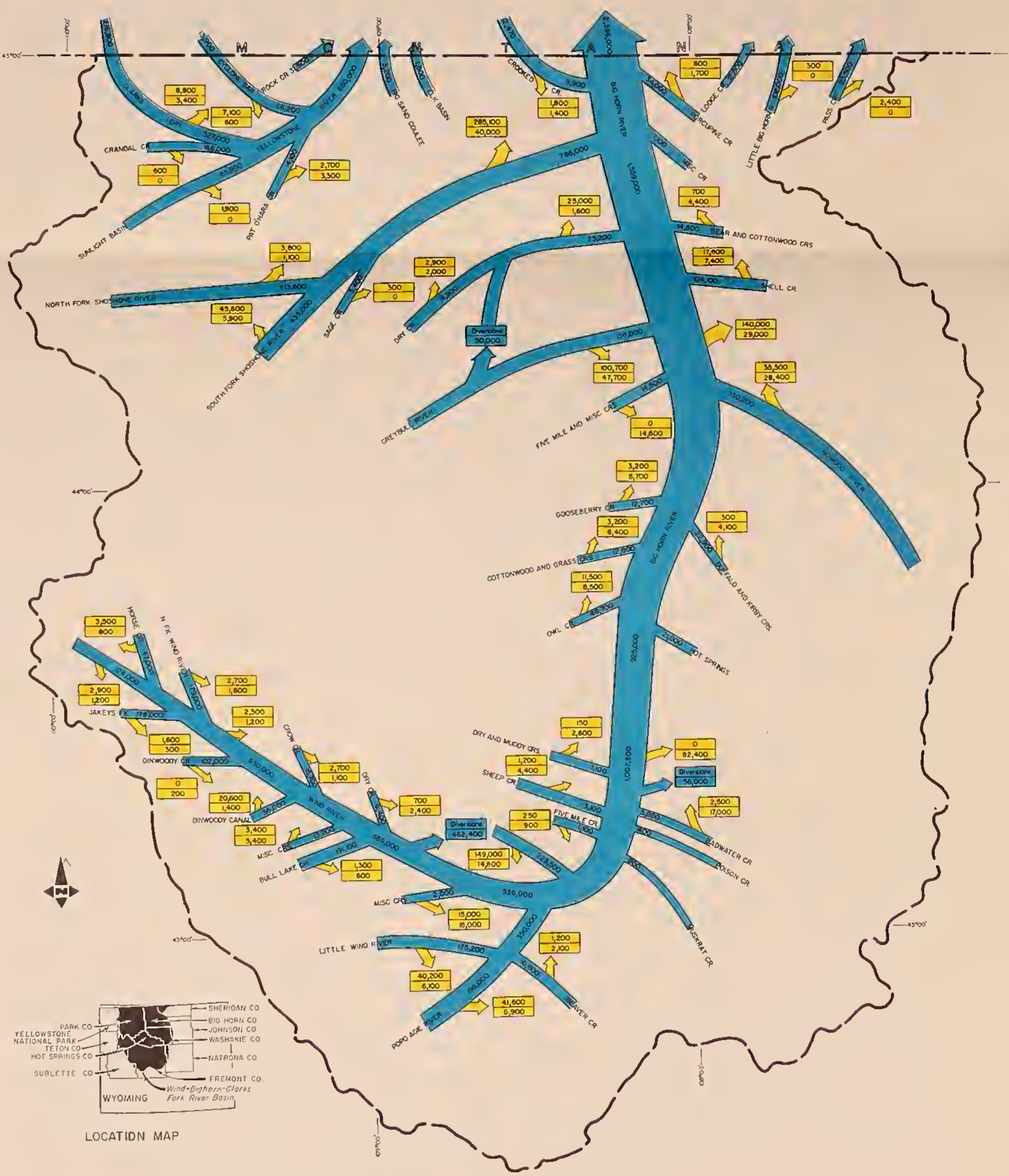
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

M7-E-22780N-N

Figure II-9--Average monthly water yields of Shell Creek near Shell, Wyoming





WATER YIELD & DEPLETIONS
(acre feet–50% change annual yield)

- 225,000 Water yield
- Depletion flow
- 2,700 / 1,800 Irrigation depletions / Evaporation and other losses
- Diversions 56,000 Diversion amount
- Diversion flow

FIGURE 11-10

SURFACE WATER FLOW CHART

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

SCALE 1:1,000,000

M7-EN-23176

Table II-11--Estimated surface water resources of the Wind-Bighorn-Clarks Fork River Basin in Wyoming, 1970

Hydrologic subareas or description	Watershed numbers	Phreato-phyte area	Present area of irrigated land	50 percent chance: Total native water yield 1/	50 percent chance: Flow from upstream sources or transfers *	50 percent chance: Phreato-phyte depletion	50 percent chance: Reservoir effects and * evaporation	50 percent chance: Available water supply	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply *	80 percent chance: Total native water yield 1/	80 percent chance: Flow from upstream sources or transfers	80 percent chance: Phreato-phyte depletion	80 percent chance: Reservoir effects and evaporation *	80 percent chance: Available water supply *	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply *
		--acres--	--acres--	--acre-feet--							--acre-feet--						
Wind River to Boyeen Reservoir																	
Wind River above Dunoir	14el-1	860	1,996	128,100	0	1,200	0	126,900	2,900	124,000	106,100	0	1,200	0	104,900	2,900	102,000
Horse Creek	14el-1a	560	2,423	51,300	0	800	0	50,500	3,500	47,000	47,300	0	800	0	46,500	3,500	43,000
Jakey's Fork, Torrey Ck. & misc.	14el-3	320	1,120	180,100	0	500	0	179,600	1,600	178,000	171,100	0	500	0	170,600	1,600	169,000
North and East Fork Wind River	14el-2,4	1,230	1,872	183,500	0	1,800	0	181,700	2,700	179,000	144,500	0	1,800	0	142,700	2,700	140,000
Dinwoody without Dinwoody Canal area	14el-6	100	0	102,200	0	200	0	102,000	0	102,000	76,200	0	200	0	76,000	0	76,000
Mainstem Wind River above Burris	--2/	760	1,317	3,500	0	1,200	0	2,300	2,300	0	3,500	0	1,200	0	2,300	2,300	0
Subtotal for Wind River at Burris	--	3,830	8,728	648,700	0	5,700	0	643,000	13,000	630,000	548,700	0	5,700	0	543,000	13,000	530,000
Dinwoody Canal & misc. creeks	14el-6	900	12,018	58,000	0	1,400	0	56,600	20,600	36,000	58,000	0	1,400	0	56,600	20,600	36,000
Crow Creek	14el-5	710	1,975	19,000	0	1,100	0	17,900	2,200	15,700	14,000	0	1,100	0	12,900	2,100	10,800
Bull Lake Creek	14el-7	380	725	193,000	0	600	0	192,400	1,300	191,100	157,000	0	600	0	156,400	1,300	155,100
Mainstem Wind River--Burris to Crowheart	--	3,240	1,958	22,000	0	5,400	0	16,600	3,400	13,200	16,900	0	5,400	0	11,500	3,400	8,100
Subtotal for Wind River at Crowheart	--	9,060	25,404	940,700	0	14,200	0	926,500	40,500	886,000	794,600	0	14,200	0	780,400	40,400	740,000
Dry Creek	14el-8	1,460	521	9,500	0	2,400	0	7,100	700	6,400	6,500	0	2,400	0	4,100	500	3,600
Diversions to Riverton Reclamation Project	14el-9	-	-	0	368,000 6/	-	-	368,000	5/	368,000	0	396,000 6/	-	-	396,000	5/	396,000
Returns through Pilot Wasteway	14el-10	-	-	0	104,000	-	-	104,000	5/	104,000	0	118,400	-	-	118,400	5/	118,400
Diversions to LeClair--Riverton #2 canal	14el-10	-	-	0	28,000	-	-	28,000	5/	28,000	0	31,000	-	-	31,000	5/	31,000
Diversions to Wyoming #2 canal	14el-10	-	-	0	66,400	-	-	66,400	5/	66,400	0	73,800	-	-	73,800	5/	73,800
Mainstem Wind River--Crowheart to Riverton	14el-10	9,600	7,270	9,300	25,700 3/	18,000	0	17,000	15,000	2,000	3,300	30,900 3/	18,000	0	16,200	15,000	1,200
Subtotal for Wind River above Riverton	--	20,120	33,195	959,500	332,700	34,600	0	592,200	56,200	536,000	804,400	-351,500	34,600	0	418,300	55,900	362,400
North, Middle, and Little Popo Agie	14ela-1,2,2a	3,480	27,213	246,700	0	6,900	0	239,800	41,800	198,000	186,800	0	6,900	0	179,900	35,800	144,100
Little Wind River, Sage, Trout, and Mill Creeks	14ela-3,4,4a	3,750	34,704	221,500	0	6,100	0	215,400	40,200	175,200	166,900	0	6,100	0	160,800	35,000	125,800
Beaver Creek	14ela-5,6	1,270	942	20,100	0	2,100	0	18,000	1,200	16,800	13,100	0	2,100	0	11,000	900	10,000
Subtotal for Little Wind River system	--	8,500	62,859	488,300	0	15,100	0	473,200	83,200	390,000	366,800	0	15,100	0	351,700	71,700	280,000
Subtotal for Wind River at Riverton	--	28,620	96,054	1,447,800	332,700	49,700	0	1,065,400	139,400	926,000	1,171,200	351,500	49,700	0	770,000	127,600	642,400
LeClair--Riverton #2 canal	14el-10	0	9,198	0	28,000	0	0	28,000	19,000	9,000	0	31,000	0	0	31,000	19,000	12,000
Wyoming #2 canal	14el-10	0	11,697	0	66,400	0	0	66,400	24,000	42,400	0	73,800	0	0	73,800	24,000	49,800
Subtotal for Riverton area large canals	14el-10	0	20,895	0	94,400	0	0	94,400	43,000	51,400	0	104,800	0	0	104,800	43,000	61,800
Adjustment for return flows above Riverton included in "Mainstem Wind River-Crowheart to Riverton" above	14el-10	-	-	-	25,700	-	-	25,700	-	25,700	-	30,900	-	-	30,900	-	30,900
Fivemile Creek and Hurley Draw	14e-4	570	316	2,250	0	900	0	1,350	250	1,100	1,600	0	900	0	700	200	500
Sheep and Muddy Creeks	14e-5	3,050	1,484	9,100	0	4,800	0	4,300	1,200	3,100	7,600	0	4,800	0	2,800	800	2,000
Dry, Muddy, & Cottonwood Creeks	14e-6	1,640	187	3,850	0	2,600	0	1,250	150	1,100	2,900	0	2,600	0	300	100	200
Riverton Reclamation Project and Ocean Lake	14el-9	7,290	73,562	0	264,000	14,800	0	249,200	149,400	99,800	0	277,600	14,800	0	262,800	149,400	113,400
Diversions (natural & artificial): Mainstem Riverton to Boysen	--	-	-	-	56,000	-	-	56,000	-	56,000	-	49,800	-	-	49,800	-	49,800
Mainstem Wind River--Riverton to Boysen	--	22,600 7/	132	0	56,000	55,700	0	300	300	0	0	49,800	49,500	0	300	300	0
Kirby Draw and Muskrat Creek	14el-12 14e2-1,2,3	1,720	0	2,000	0	1,200	0	800	0	800	1,600	0	1,200	0	400	0	400
Poison Creek	14e-1,3	2,150	0	1,900	0	1,500	0	400	0	400	1,700	0	1,500	0	200	0	200
Badwater Creek	14e3-1,2,3,4	8,380	3,139	25,300	0	17,000	0	8,300	2,500	5,800	20,700	0	17,000	0	3,700	1,400	2,300
Subtotal for Wind River above Boysen Reservoir	--	76,020	195,769	1,492,200	0	148,200	0	1,344,000	336,200	1,007,800	1,107,300	0	142,000	0	1,065,300	322,800	742,500

Table II-11--Estimated surface water resources (Continued)

Hydrologic subarea or description	Watershed numbers	Phreatophyte area	Present area of irrigated land	50 percent chance: Total native water yield 1/	50 percent chance: Flow from upstream sources or transfers	50 percent chance: Phreatophyte depletion	50 percent chance: Reservoir effects and evaporation	50 percent chance: Available water supply	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply	80 percent chance: Total native water yield 1/	80 percent chance: Flow from upstream sources or transfers	80 percent chance: Phreatophyte depletion	80 percent chance: Reservoir effects and evaporation	80 percent chance: Available water supply	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply
		acres	acres	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet
Boysen Reservoir evaporation	-	-	-	-	-	-	47,800	47,800	-	47,800	-	-	-	42,500	42,500	-	42,500
Boysen Reservoir change in storage	-	-	-	-	-	-	35,000	35,000	-	35,000	-	-	-	40,000	40,000	-	40,000
Total for Wind River below Boysen Reservoir	-	76,020	195,769	1,492,200	0	148,200	82,800	1,261,200	336,200	925,000	1,207,300	0	142,000	-2,500	1,062,800	322,800	740,000
Bighorn River from Boysen to Kane																	
Owl, Mud, and Red Canyon Creeks	14e-6a, 8, 8a, 9, 10, 10b, 13	6,400	15,678	66,500	0	8,500	0	58,000	11,300	46,700	48,500	0	8,500	0	40,000	7,800	32,200
Buffalo, Kirby, & Nowater Creeks	14e-7, 11, 12, 12a	2,560	384	27,300	0	4,100	0	23,200	300	22,900	17,200	0	4,100	0	13,100	200	12,900
Cottonwood and Grass Creeks	14e-14, 16	5,890	2,918	22,400	0	6,400	0	16,000	3,200	12,800	16,400	0	6,400	0	10,000	2,400	7,600
Gooseberry Creek	14e-15	6,850	3,818	24,600	0	8,700	0	15,900	3,200	12,700	18,700	0	8,700	0	10,000	2,200	7,800
Fifteen, Five Mile, & Elk Creeks	14e-17, 19, 20, 21	9,470	0	29,400	0	14,600	0	14,800	0	14,800	22,000	0	14,600	0	7,400	0	7,400
Nowood River	14e4-1 to 7	11,460	19,167	414,400	0	28,900	0	385,500	35,300	350,200	355,600	0	28,900	0	326,700	34,100	292,600
Greybull River	14e5-1 to 4	17,980	51,388	306,400	0	47,700	0	285,700	100,700	158,000	235,000	0	47,700	0	187,300	78,300	109,000
Dry Creek above Bench Canal	14e-25, 26	1,080	1,163	9,800	0	2,000	0	7,800	2,900	4,900	6,300	0	2,000	0	4,300	2,900	1,400
Diversions to Dry Creek	14e5-4	-	-	-	50,000	-	-	50,000	-	50,000	-	50,000	-	-	50,000	-	50,000
Dry Creek below Bench Canal	14e5-4	970	12,705	-	50,000	1,800	0	48,200	25,000	23,200	-	50,000	1,800	-	48,200	25,000	23,200
Shell Creek	14e-22, 23	4,100	10,493	129,100	0	7,400	0	121,700	17,600	104,100	109,200	0	7,400	0	101,800	16,400	85,400
Bear Creek to Cottonwood Creek	14e-24, 24a	4,480	78	19,400	0	4,400	0	15,000	200	14,800	17,400	0	4,400	0	13,000	200	12,800
Thermopolis Hot Springs	14e-10a	-	-	21,000	0	0	0	21,000	0	21,000	21,000	0	0	0	21,000	0	21,000
Mainstem Bighorn River	14e-10c, 17a, 17b, et. al.	16,000	61,579	66,900	0	29,000	0	37,900	140,000	102,100 8/	62,700	0	29,000	0	33,700	140,000	106,300 8/
Subtotal for Bighorn Basin	--	87,240	179,371	1,137,200	0	163,500	0	973,700	339,700	634,000	930,000	0	163,500	0	766,500	309,500	457,000
Total for Wind-Bighorn Basin at Kane	--	163,260	375,140	2,629,400	0	311,700	82,800	2,234,900	675,900	1,559,000	2,137,300	0	305,500	-2,500	1,829,300	632,300	1,197,000
Shoshone River																	
North Fork Shoshone River	14e6a-1, 2, 2a	1,420	1,977	629,500	0	1,100	11,000	617,400	3,800	613,600	521,000	0	1,100	11,000	508,900	3,800	505,100
South Fork Shoshone River	14e6-1, 2, 3	7,620	23,641	497,500	0	5,900	11,000	480,600	45,600	435,000	413,000	0	5,900	11,000	396,100	45,600	350,500
Sage Creek near Cody	14e6-3	0	408	3,900	0	0	0	3,900	500	3,400 9/	2,500	0	0	0	2,500	400	2,100 9/
Lower Shoshone River	14e6-5,6,7,8,8a	21,940	122,698	41,610	17,490	40,000	0	19,100	285,100	266,000 9/	37,120	11,280	30,000	0	18,400	285,100	266,700 9/
Subtotal for Shoshone River	--	30,980	148,724	1,172,510	17,490	47,000	22,000	1,121,000	335,000	786,000	973,620	11,280	37,000	22,000	925,900	334,900	591,000
Total for Wind-Bighorn-Shoshone Rivers at Kane	--	194,240	523,864	3,801,910	17,490	358,700	104,800	3,355,900	1,010,900	2,345,000	3,110,920	11,280	342,500	24,500	2,755,200	967,000	1,788,000
Crooked Creek	14e-27	510	1,079	630	12,470	1,400	0	11,700	1,800	9,900	450	8,650	1,400	0	7,700	1,600	6,100
Porcupine Creek	14e-28	640	329	36,300	0	1,700	0	34,600	600	34,000	29,300	0	1,700	0	27,600	600	27,000
Local inflow Kane to state line	14e-24a, 27, 28	-	-	7,100	0	0	0	7,100	0	7,100	5,900	0	0	0	5,900	0	5,900
Total for Wyoming portion Bighorn River Basin at state line	--	195,390	525,272	3,845,940	29,960	361,800	104,800	3,409,300	1,013,300	2,396,000	3,146,570	19,930	345,600	24,500	2,796,400	969,400	1,827,000
Clarks Fork of Yellowstone																	
Crandall Creek	14c-2	0	303	166,600	0	0	0	166,600	600	166,000	142,800	0	0	0	142,800	600	142,200
Sunlight Basin area	14c-1	0	967	87,800 10/	0	0	0	87,800	1,900	85,900	75,200 10/	0	0	0	75,200	1,900	73,300
Cyclone Bar	14c-5	320	3,679	60,200 10/	13,900	800	0	73,300	7,100	66,200	52,200 10/	11,900	800	0	63,300	7,100	56,200
Pat O'Hara Creek	14c-4	1,280	1,595	20,100 10/	0	3,300	0	16,800	2,700	14,100	17,700 10/	0	3,300	0	14,400	2,600	11,800
Clarks Fork	14c-3, 6, 7	1,410	4,575	123,400 10/	216,800	3,600	0	336,600	8,800	327,800	111,600 10/	177,300	3,600	0	285,300	8,800	276,500
Subtotal for mainstem Clarks Fork at state line	--	3,010	11,119	458,100	230,700	7,700	0	681,100	21,100	660,000	399,500	189,200	7,700	0	581,000	21,000	560,000

Table II-11--Estimated surface water resources (Continued)

Hydrologic subareas or description	Watershed numbers	Phreato-phyte area	Present area of irrigated land	50 percent chance: Total native water yield 1/	50 percent chance: Flow from upstream sources or transfers	50 percent chance: Phreato-phyte depletion	50 percent chance: Reservoir effects and evaporation	50 percent chance: Available water supply	50 percent chance: Irrigation depletion	50 percent chance: Remaining water supply	80 percent chance: Total native water yield 1/	80 percent chance: Flow from upstream sources or transfers	80 percent chance: Phreato-phyte depletion	80 percent chance: Reservoir effects and evaporation	80 percent chance: Available water supply	80 percent chance: Irrigation depletion	80 percent chance: Remaining water supply
		acres	acres	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet	acre-feet
Upper Rock Creek in Wyoming	14c-8	0	0	31,500	0	0	0	31,500	0	31,500	26,000	0	0	0	26,000	0	26,000
Big Sand Coulee in Wyoming	14c-4a	0	0	3,200	0	0	0	3,200	0	3,200	2,200	0	0	0	2,200	0	2,200
Elk Basin	14c-6	0	0	1,800	0	0	0	1,800	0	1,800	1,300	0	0	0	1,300	0	1,300
Total for Clarks Fork Basin in Wyoming	--	3,010	11,119	494,600	230,700	7,700	0	717,600	21,100	696,500	429,000	189,200	7,700	0	610,500	21,000	589,500
Little Bighorn River																	
Lodge Grass Creek in Wyoming	14e7-3	0	0	12,800	0	0	0	12,800	0	12,800	10,300	0	0	0	10,300	0	10,300
Upper Little Bighorn River	14e7-1	0	163	102,300	0	0	0	102,300	300	102,000	82,300	0	0	0	82,300	300	82,000
Pass Creek in Wyoming	14e7-2	0	2,278	25,900	0	0	0	25,900	2,400	23,500	20,900	0	0	0	20,900	2,000	18,900
Total for Little Bighorn River	--	0	2,441	141,000	0	0	0	141,000	2,700	138,300	113,500	0	0	0	113,500	2,300	111,200
Total for Wind-Bighorn-Clarks Fork leaving Wyoming	--	198,400	538,832	4,482,090	260,110	369,500	104,800	4,267,900	1,037,100	3,230,800	3,689,430	208,770	353,300	24,500	3,520,400	992,700	2,527,700

1/ Except that flow required to supply evaporation from flowing streams or small lakes and ponds is not estimated. For the purpose of this table, riparian phreatophytes are considered part of the stream system, though partly supplied by inflowing ground water.
2/ -- means no number is needed.
3/ Includes return flows from Riverton #2 and Wyoming #2 canals.
4/ - means no number applies
5/ A more detailed water budget for these areas is included below.
6/ A negative sign (-) denotes a diversion or transfer. A plus (+) sign denotes return flows. Native surface water yields for these areas are included in other areas listed in the table.
7/ Includes some areas not mapped because of identification problems on aerial photographs.
8/ Supplied from Boysen Reservoir from Wind River streamflows.
9/ Supplied from Buffalo Bill Reservoir from North and South Fork Shoshone River streamflows.
10/ Includes flows from Montana portions of watersheds 14c-3 and 14c-5.

*Numbers in these columns may represent either increasing or decreasing effects according to the description in the first column in the table.

formations are usually deeply buried and may be encountered within favorable drilling depths only along a narrow band at the base of the mountains and along the associated structures. Flowing wells of up to 7 cubic feet of water per second have been reported from these formations.

Figure II-11 shows the general availability of ground water. It shows the depth within which ground water may be expected and the amount of ground water that may be expected from wells within certain areas. This map is generalized, and consequently, does not show local detail. Therefore, proposals for individual wells should be evaluated by a qualified person to determine ground-water potential at specific sites. Another part of this figure shows the locations of areas covered by existing ground-water reports.

FISH AND WILDLIFE RESOURCES

Low human population density, large amounts of public lands, wide variations in climate and elevation are factors which provide varied and plentiful wildlife habitat. The impacts on fish and wildlife resources must be carefully considered when planning the conservation and development of other resources.

Big game habitat

The habitat for big game animals ranges from alpine peaks to grasslands-sagebrush plains, irrigated croplands, and deserts. Table II-12 lists big game species and the estimated extent of their habitat in the basin. This information has been compiled from the Wyoming Game and Fish Commission Planning Reports.

Figure II-12 is a series of maps showing areas and value of habitat for deer, antelope, elk, moose, bighorn sheep, mountain goat, and bear within the basin. These maps are taken from the Missouri River Basin Comprehensive Framework Study report on fish and wildlife tentative needs and problems in the Yellowstone River Subbasin.

The condition of big game habitat is generally good with the most serious limitation being winter range for elk, moose, and deer. Population estimates of basic herd numbers for the winter carry-over are shown in table II-13. Also listed are 1969 harvest estimates.

Upland and small game habitat

Upland game habitat varies from forested mountains to sagebrush-grassland plains. Most of the habitat lands are also utilized for livestock range. Table II-14 lists estimated areas of habitat and the 1969 harvest of species of upland game.

Figure II-13 is a series of maps from the Missouri River Basin Comprehensive Framework Study showing areas and quality of habitat for pheasant, turkey, sharp-tailed grouse, mountain grouse, (blue and ruffed grouse),

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE SDB&SCS-PORTLAND, OREG. 1970

STRATIGRAPHIC LEGEND
FOR GENERAL AVAILABILITY OF GROUNDWATER MAP
WIND-BIGHORN-CLARKS FORK RIVER BASIN

WYOMING PORTION

AGE			FORMATION NAME	WATER BEARING PROPERTIES	EXPECTED YIELDS	1/ USUAL QUALITY
QUATERNARY			Valley Alluvium	Water Bearing	** 50 - 450 gpm	Fair to Good
TERTIARY	Miocene		Miocene & Oligocene Rocks	Water Bearing Properties Unknown		
TERTIARY	Oligocene		*Intrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Eocene		Extrusive Pyroclastics	Non-Water Bearing		
TERTIARY	Eocene		Upper & Middle Eocene Rocks	Water Bearing	Less than 50 gpm	Good
TERTIARY	Eocene		Wind River Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Eocene		Wasatch Formation	Water Bearing	Less than 50 gpm	Fair
TERTIARY	Paleocene		Fort Union Formation	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER		Lance & Meeteetse Formation	Water Bearing	Less than 50 gpm	Fair
CRETACEOUS	UPPER		Mesaverde Group	Water Bearing	*** Less than 50 gpm	Fair to Good
CRETACEOUS	UPPER	COLORADO GROUP	*Cody Shale	Non-Water Bearing		
CRETACEOUS	UPPER	COLORADO GROUP	Frontier Formation	Water Bearing	*** Less than 50 gpm	Poor
CRETACEOUS	LOWER	COLORADO GROUP	*Mowry & Thermopolis Shales	Non-Water Bearing		
CRETACEOUS	LOWER		Cloverly & Morrison Formations	Water Bearing	*** Less than 50 gpm	Fair to Good
JURASSIC			Sundance Formation	Water Bearing	*** Less than 50 gpm	Poor
JURASSIC			*Gypsum Spring Formation	Non-Water Bearing		
TRIASSIC			Chugwater Formation	Non-Water Bearing		
TRIASSIC			*Dinwoody Formation	Non-Water Bearing		
PERMIAN			Phosphoria Formation	Water Bearing	Less than 50 gpm	Poor
PENNSYLVANIAN			Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN			Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN			Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN			*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN			Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
CAMBRIAN			Gros Ventre Formation	Non-Water Bearing		
CAMBRIAN			*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN			*Metamorphic & Igneous Rocks	Non-Water Bearing		

* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.

M7-N-22780G-2

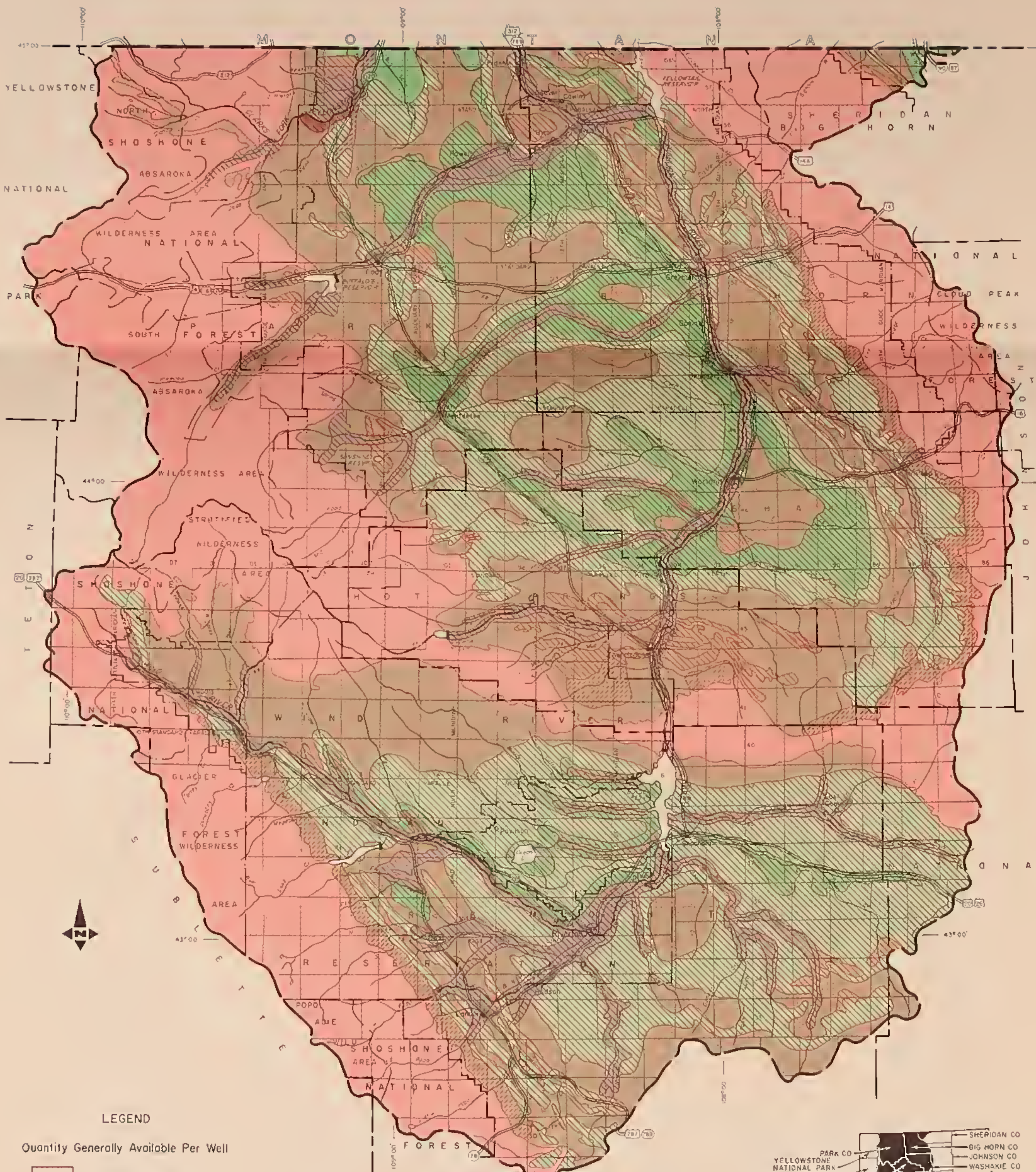
PENNSYLVANIAN	Tensleep Sandstone & Amsden Group	Water Bearing	50 - 450 gpm	Fair to Good
MISSISSIPPIAN	Madison Group	Water Bearing	Over 450 gpm	Good
DEVONIAN	Darby Formation	Water Bearing	Less than 50 gpm	Good
ORDOVICIAN	*Bighorn Dolomite	Non-Water Bearing		
CAMBRIAN	Gallatin Limestone	Water Bearing	Less than 50 gpm	Poor to Fair
	Gros Ventre Formation	Non-Water Bearing		
	*Flathead Quartzite	Water Bearing	Over 450 gpm	Good
PRECAMBRIAN	*Metamorphic & Igneous Rocks	Non-Water Bearing		

* These units may yield some water, but because of excessive mineralization, difficulty of drilling, massive structure, excessive depth in relation to yield and/or high elevation of outcrop areas, these formations are not normally considered aquifers.

** Larger yields may be obtained in local areas of thick, saturated deposits of high permeability, or by installing collector galleries or well-point systems in areas of thinner deposits.

*** These formations may contain confined water under artesian pressure, and wells penetrating a complete saturated section of these formations may produce more than the yield indicated here. Some areas may be tightly cemented and produce less than indicated here.

1/ Good - Usually suitable for most purposes.
Fair - Suitable for most purposes except domestic uses and irrigation of certain soils.
Poor - Excessively mineralized and not suitable for most uses.



LEGEND

Quantity Generally Available Per Well

- Less than 50 gpm
- 50–450 gpm
- More than 450 gpm

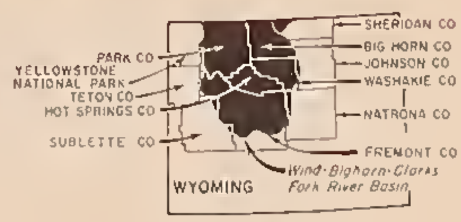
Depth Within Which Ground Water May Be Expected

Alluvium

- Less than 100 Feet

Bedrock

- Less than 300 Feet
- 300–600 Feet
- 600–3,500 Feet
- Ground water not generally available



LOCATION MAP

FIGURE II-11

GENERAL AVAILABILITY OF GROUND WATER

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

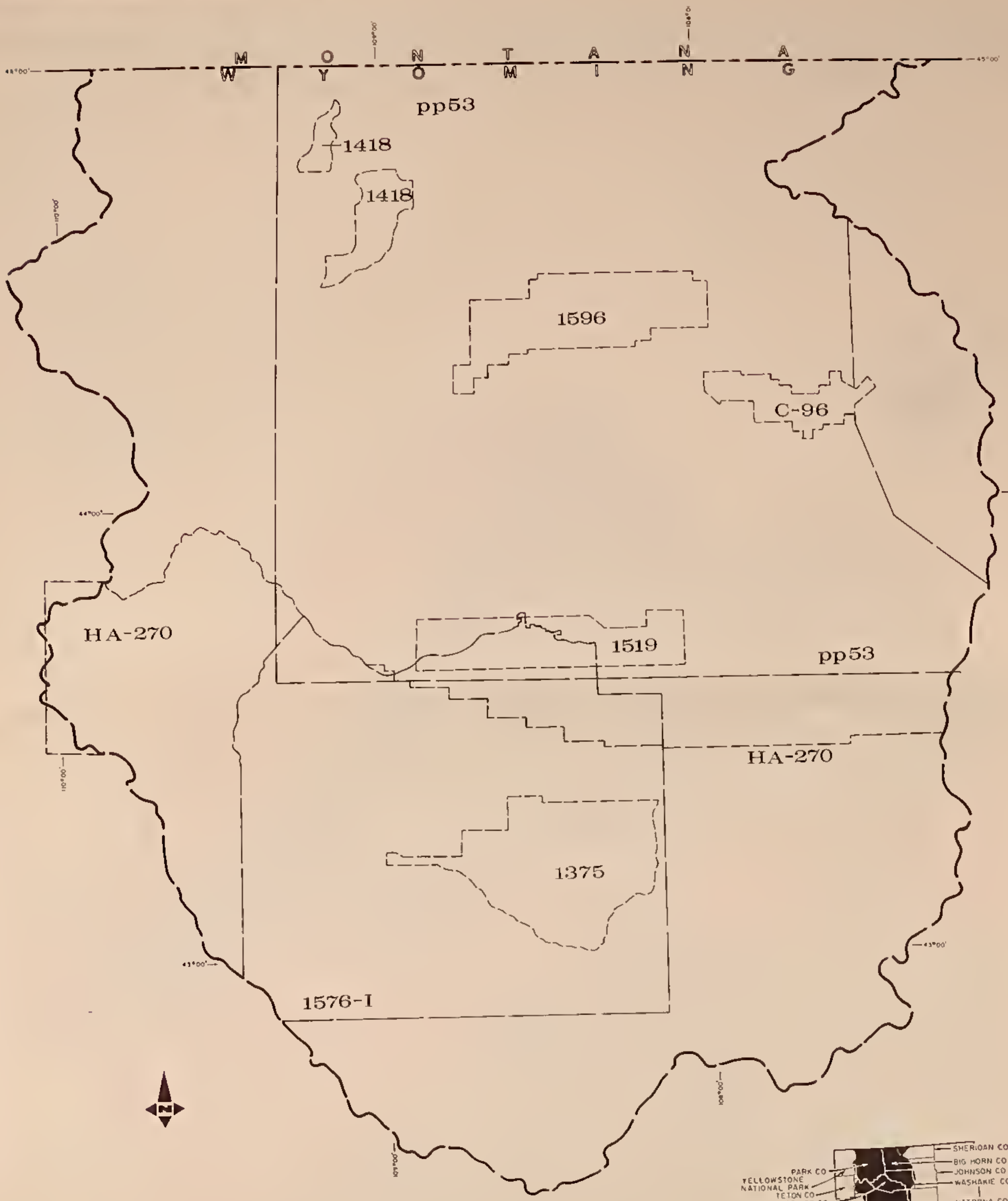
10 0 10 20 MILES

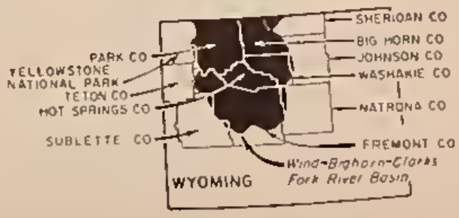
SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22780G-N

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE





LOCATION MAP

BIBLIOGRAPHY OF GROUND WATER AND RELATED STUDIES

WYOMING

1596	USGS Water Supply Paper 1596, Geology and Ground Water Resources of the Greybull River - Dry Creek Area, Wyoming; C.J. Rabinove and R.H. Langford.
1519	USGS Water Supply Paper 1519, Geology and Ground Water Resources of the Owl Creek Area, Hot Springs County, Wyoming; D.W. Barry and R.T. Littleton.
1418	USGS Water Supply Paper 1418, Geology and Ground Water Heart Mountain and Chapman Bench Divisions, Shoshone Irrigation Project, Wyoming; H.A. Swenson.
1375	USGS Water Supply Paper 1375, Ground Water Resources of Riverton Irrigation Project Area, Wyoming; D.A. Morris, O.M. Hackett, K.E. Vanlier, and E.A. Moulder.
1576-I	USGS Water Supply Paper 1576-I, Ground Water Resources of the Wind River Indian Reservation, Wyoming; L.J. McGreavy, W.G. Hodson, and S.J. Rucker.
pp53	USGS Professional Paper 53, 1906; Geology and Water Resources of the Bighorn Basin, Wyoming; C.A. Fisher.
C-96	USGS Circular 96, Ground Water Resources of the Paintrock Irrigation Project, Wyoming; F.A. Swenson and W.K. Bach.
HA-270	U.S. Geological Hydrologic Atlas 270, Ground Water Resources and Geology of the Wind River Basin Area, Central Wyoming; H.A. Witcomb and H.E. Lowry.

AREAS COVERED BY GROUND WATER REPORTS
WIND - BIGHORN - CLARKS FORK RIVER BASIN
WYOMING

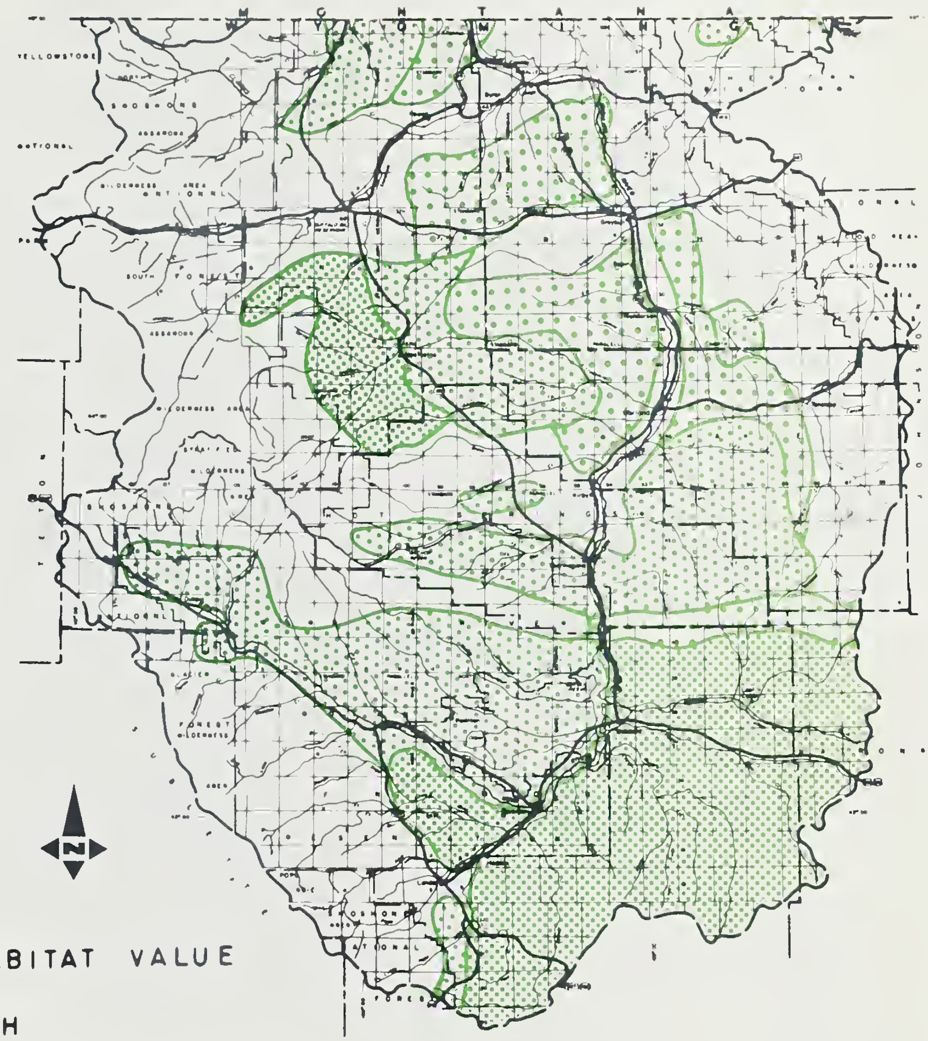
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,100,000

M7-N-22780G-1



ANTELOPE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

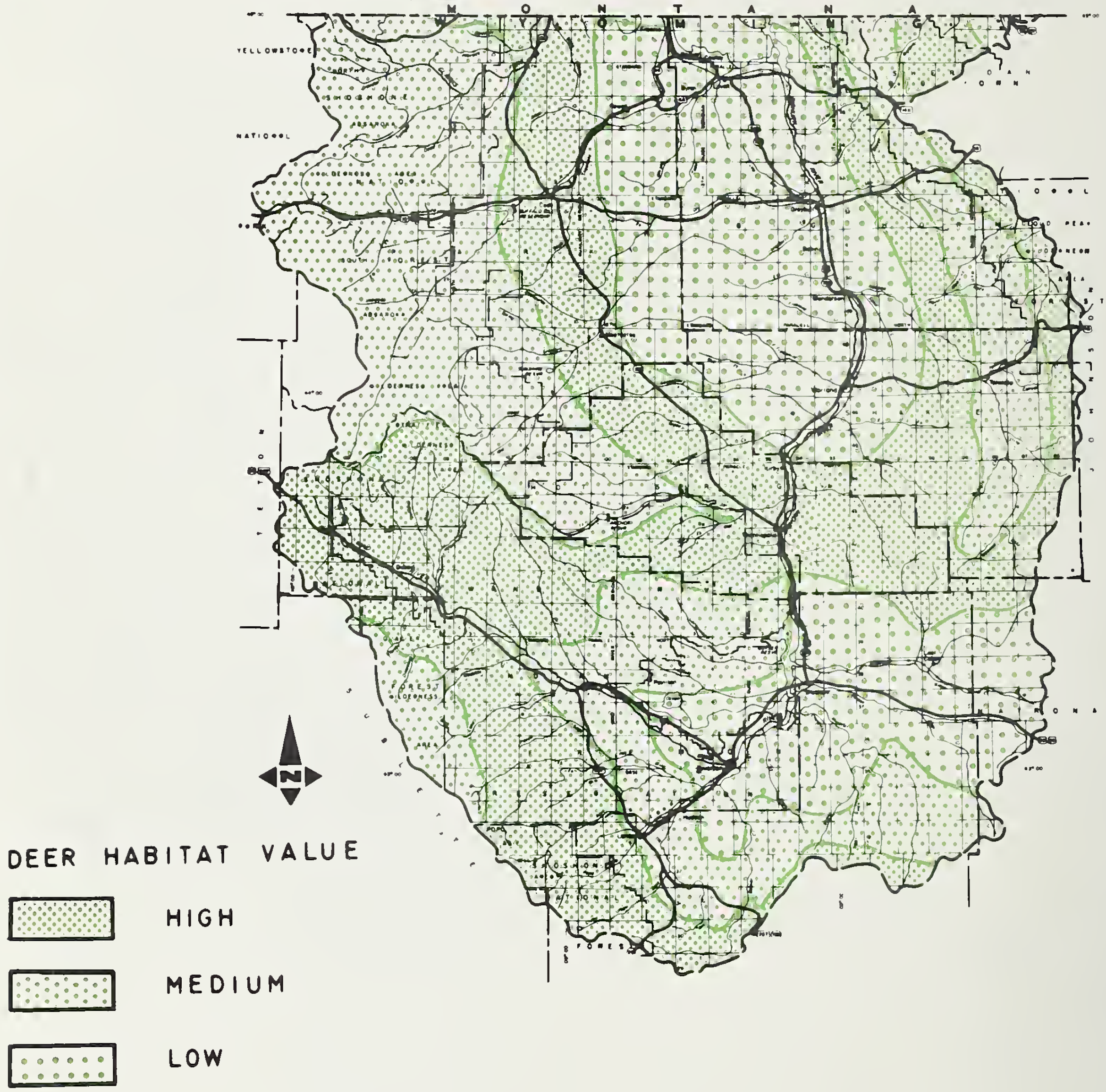


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND OREG. 1975

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

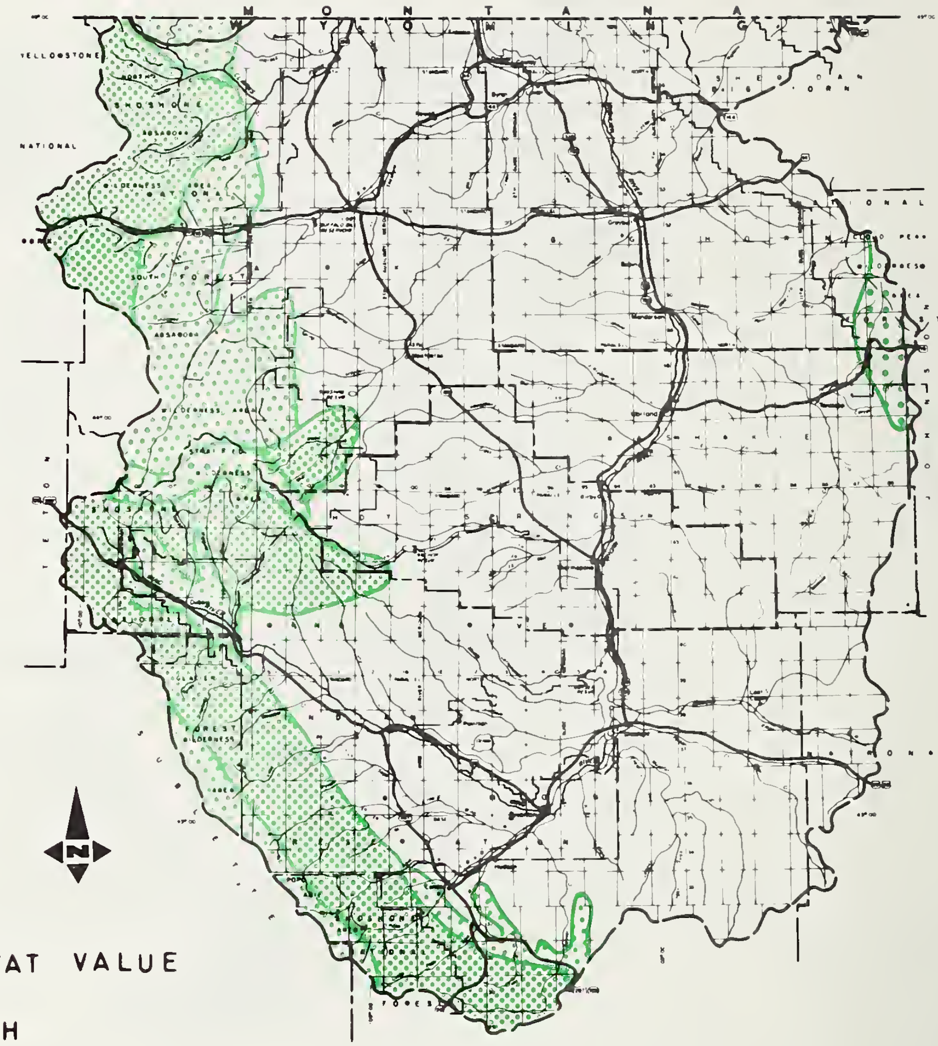
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study



MOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

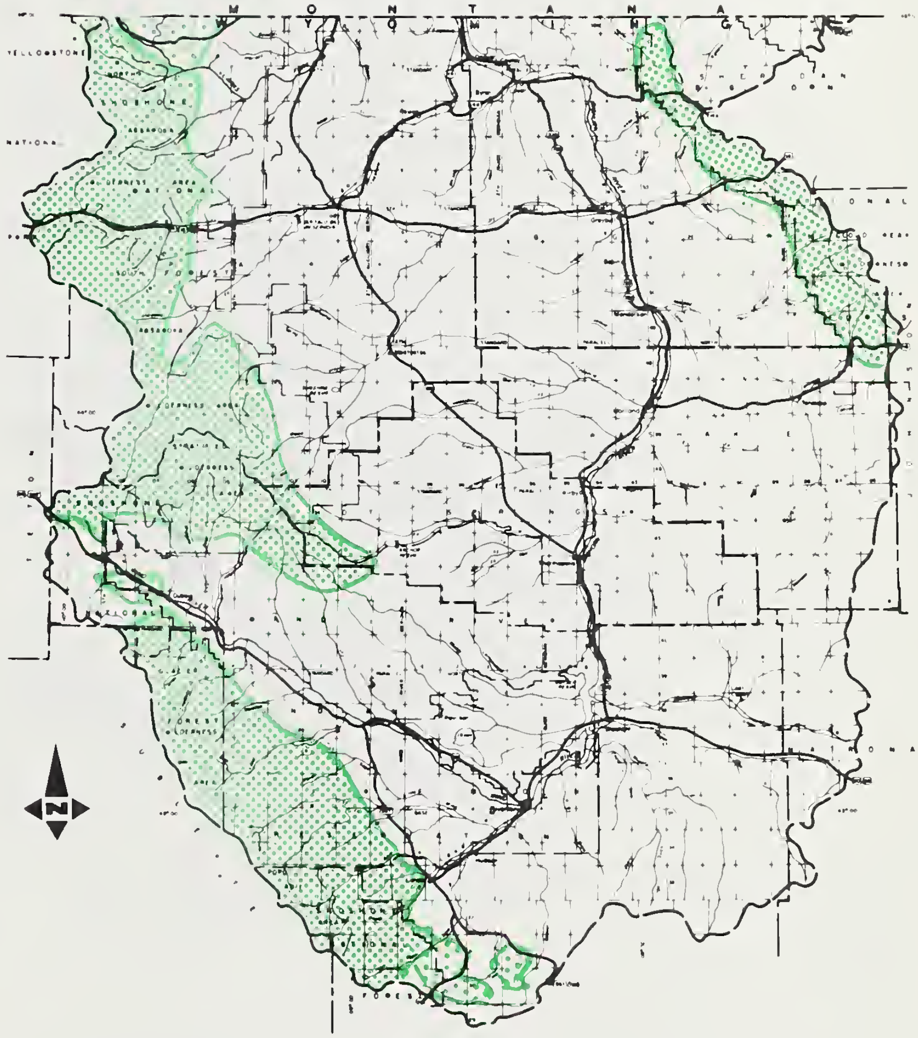
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



BIGHORN SHEEP
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE 11-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

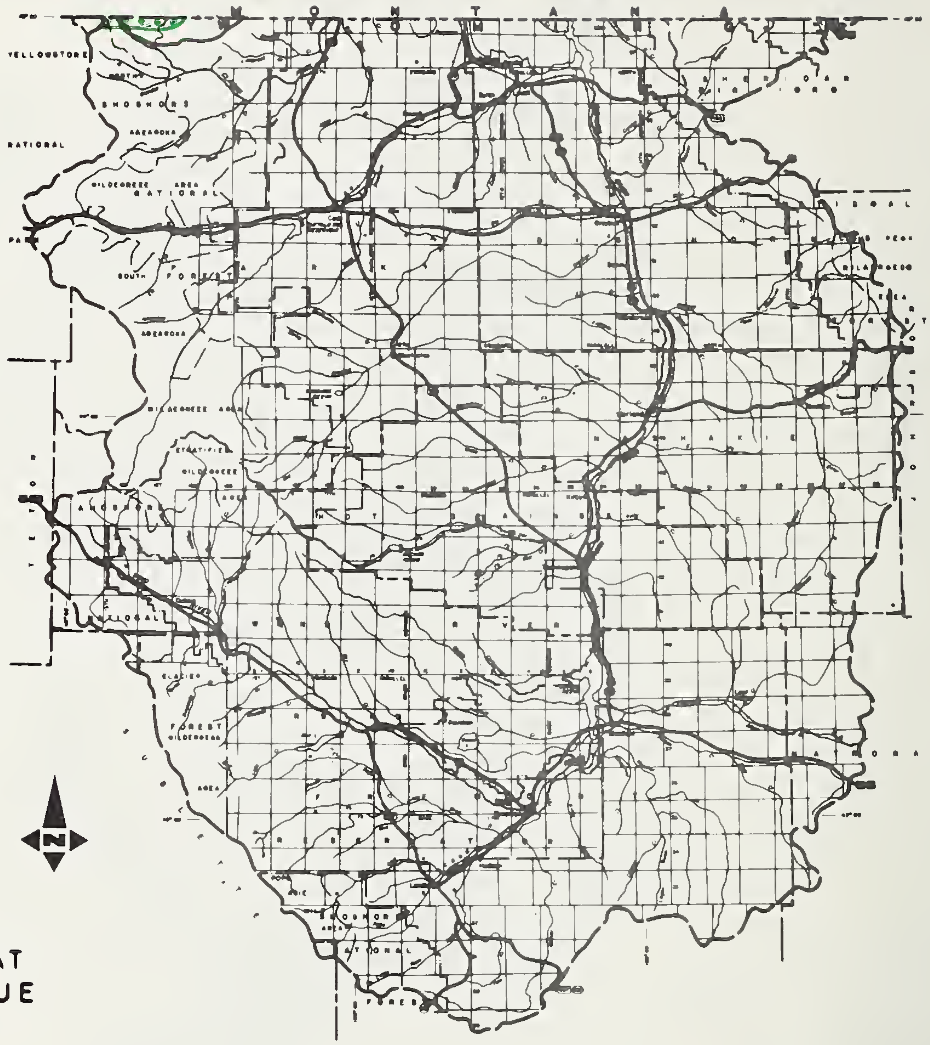
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



MOUNTAIN GOAT HABITAT VALUE

- HIGH
- MEDIUM
- LOW

FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

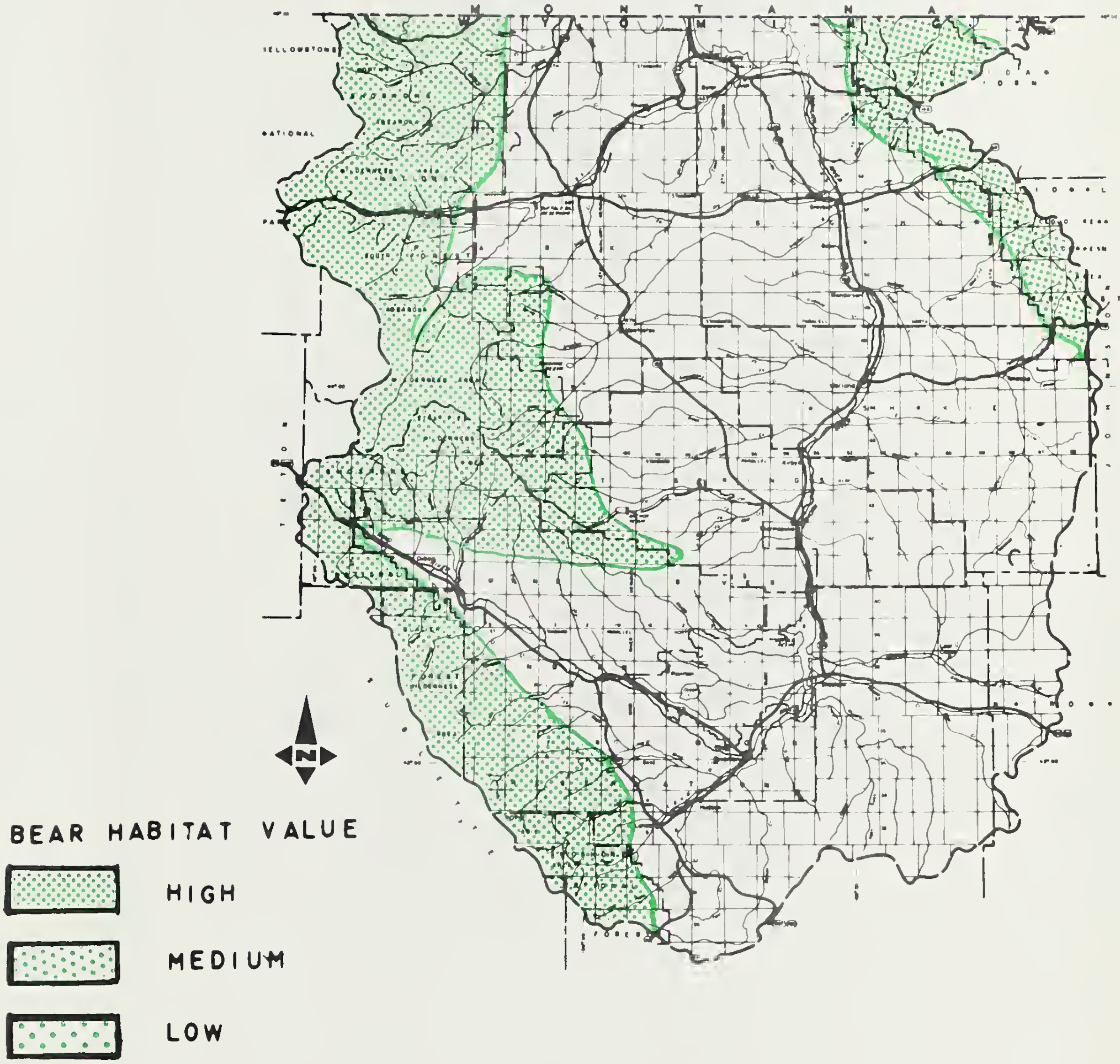


FIGURE II-12

BIG GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

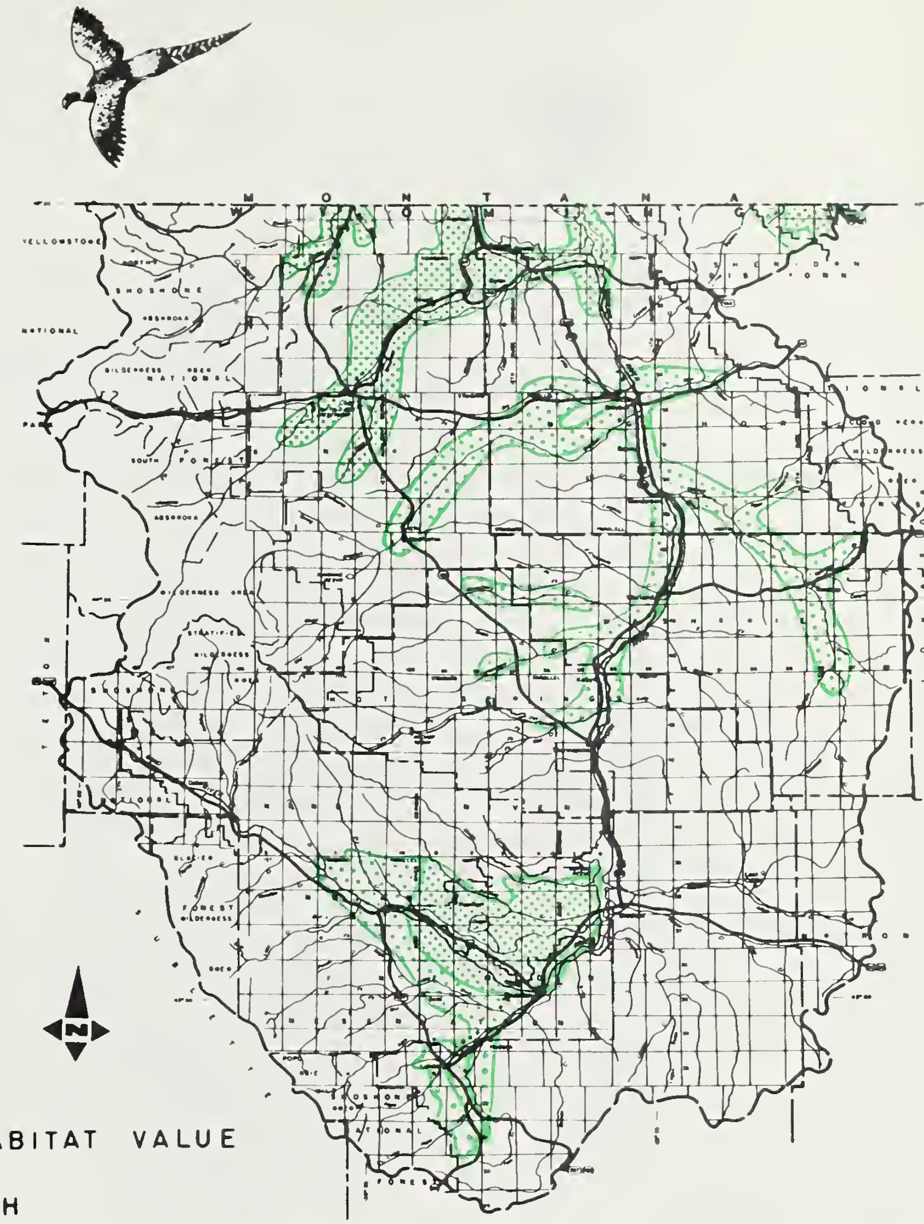
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975



PHEASANT HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

0504-SCS-PORTLAND, OREG 1975

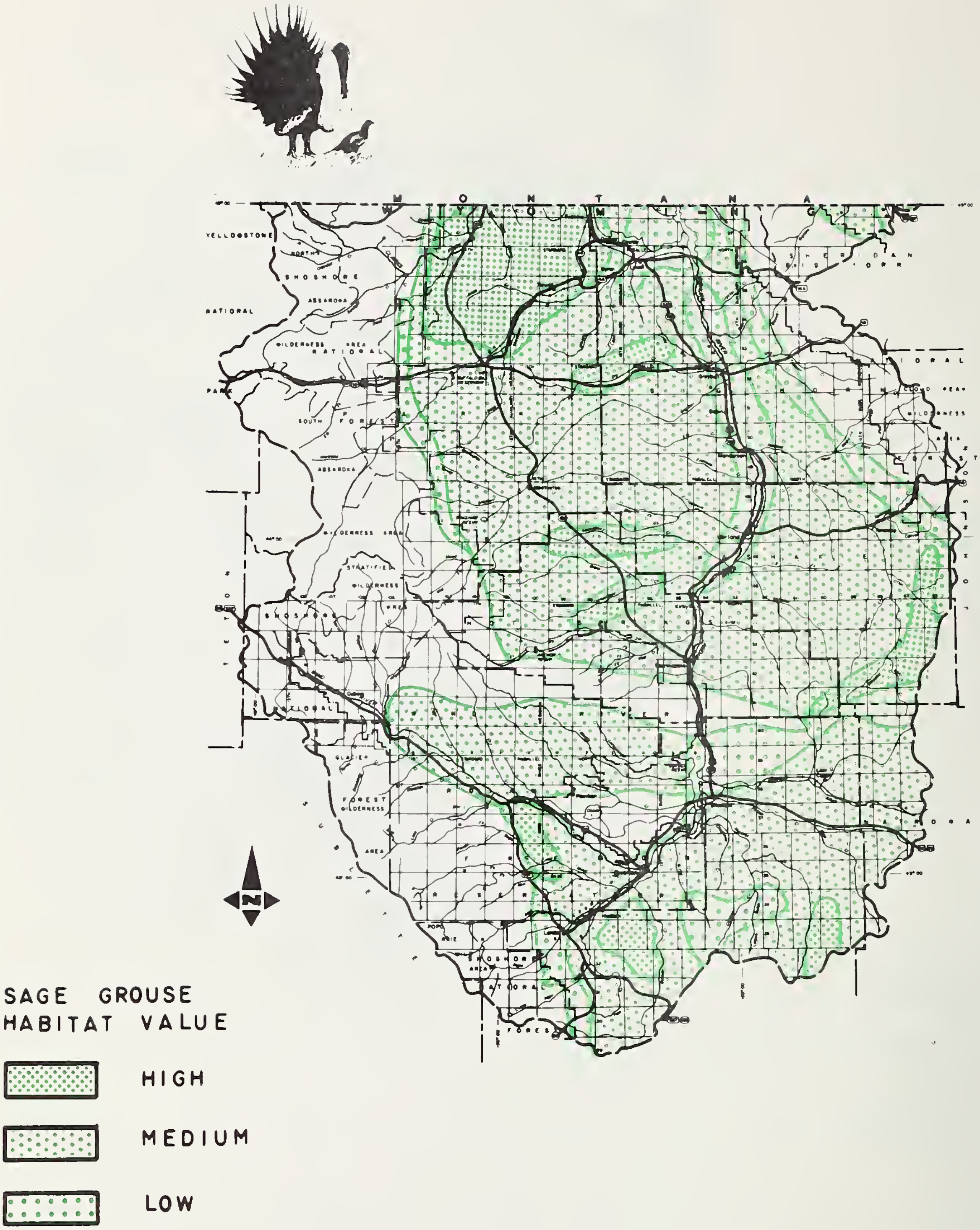


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

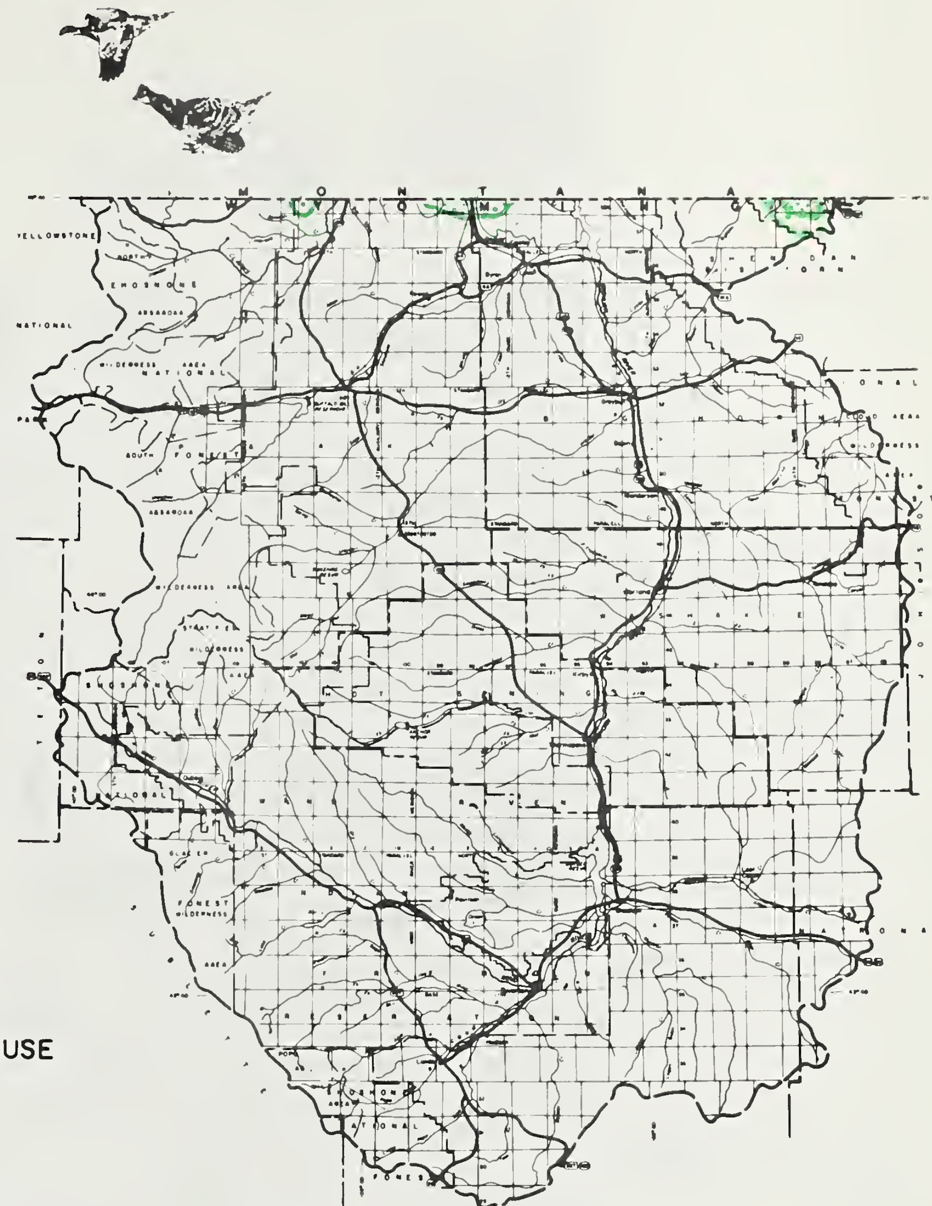
DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study



SHARP–TAILED GROUSE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975

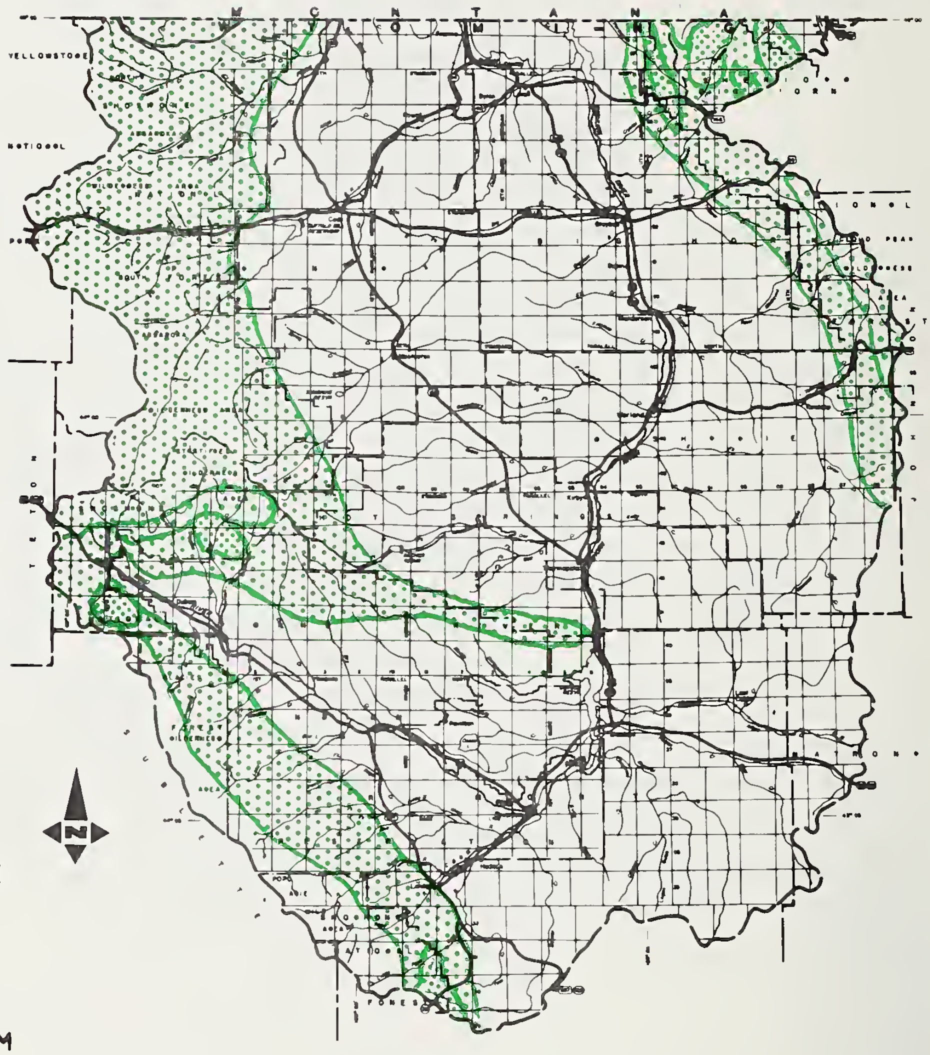


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

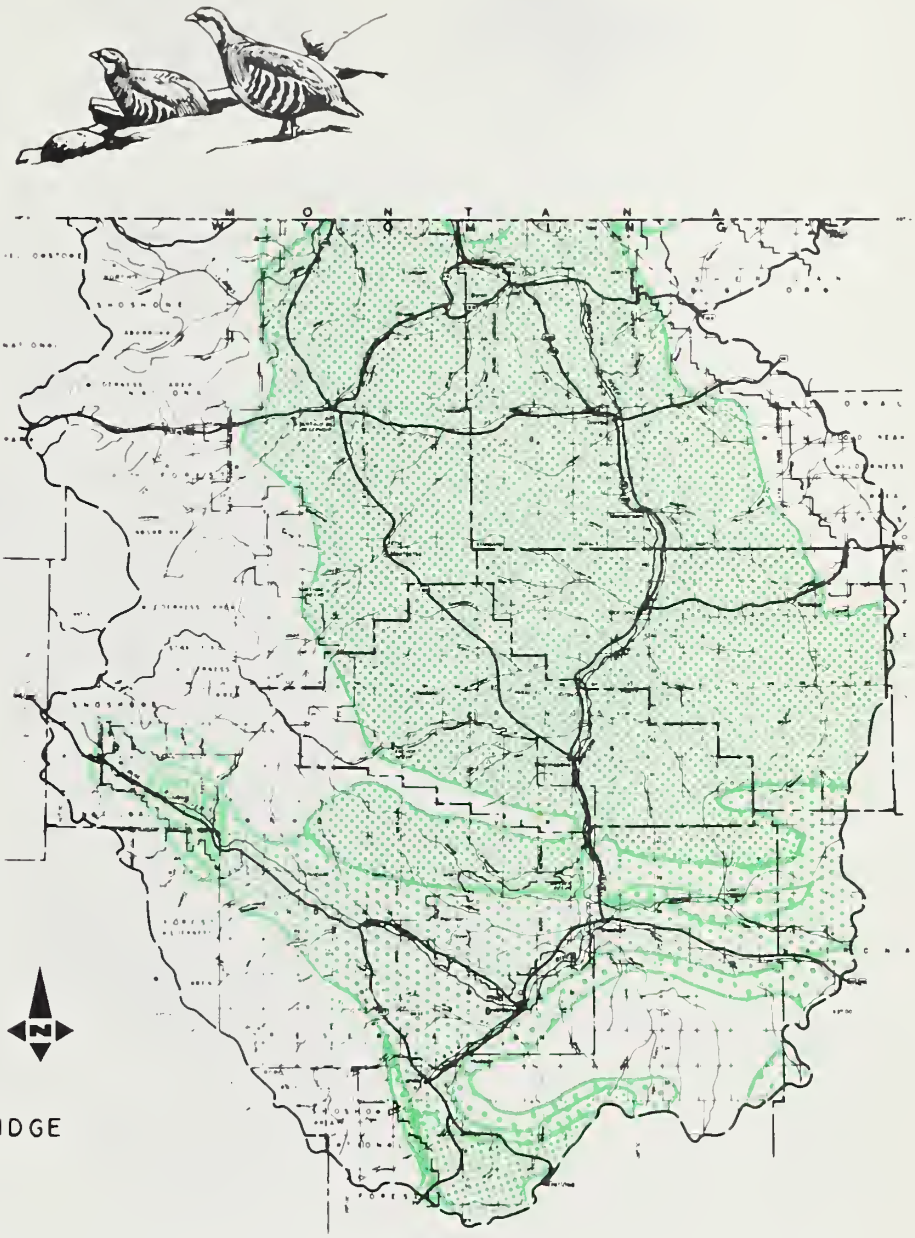
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG 1975



CHUKAR PARTRIDGE
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

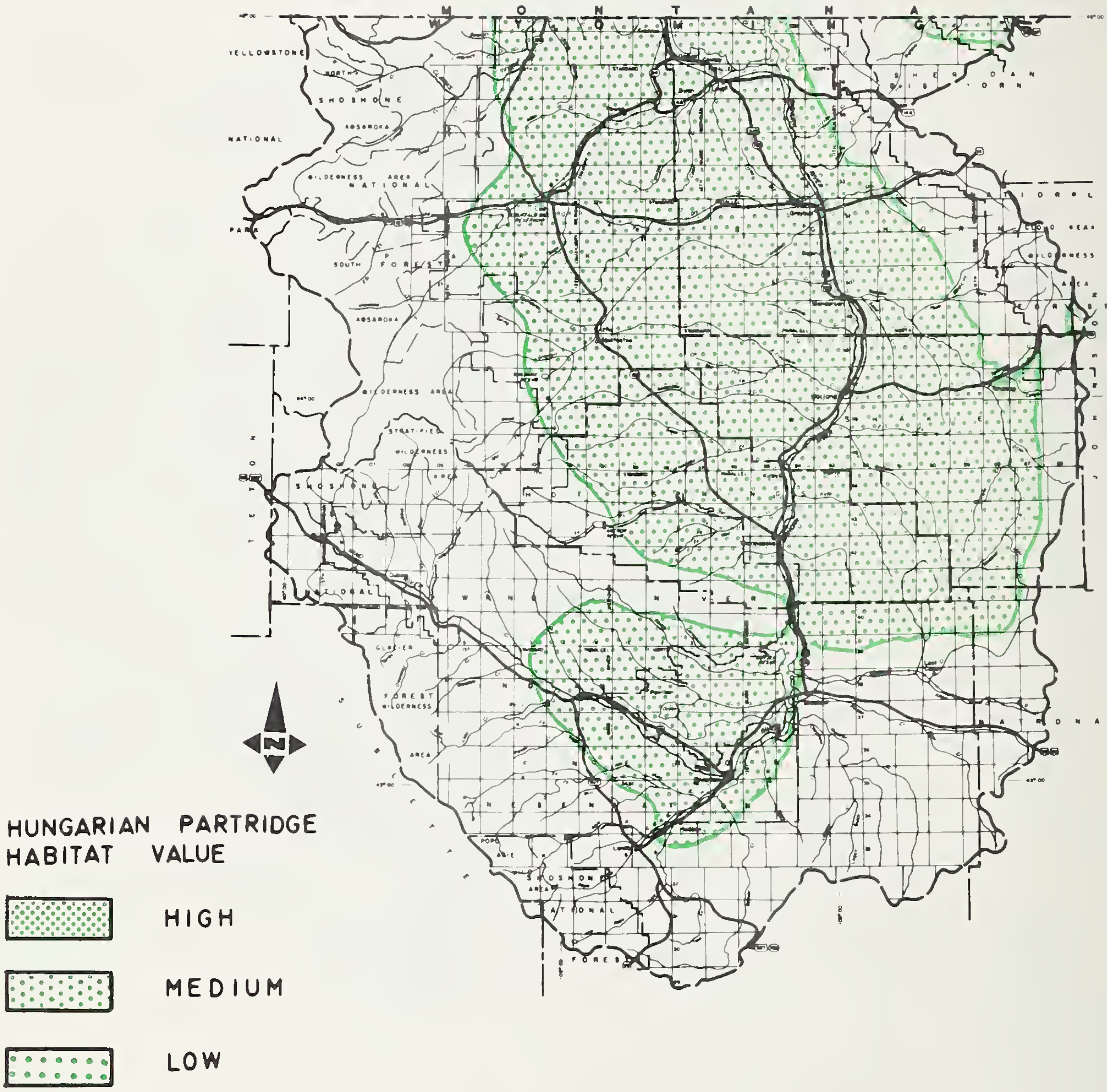


FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

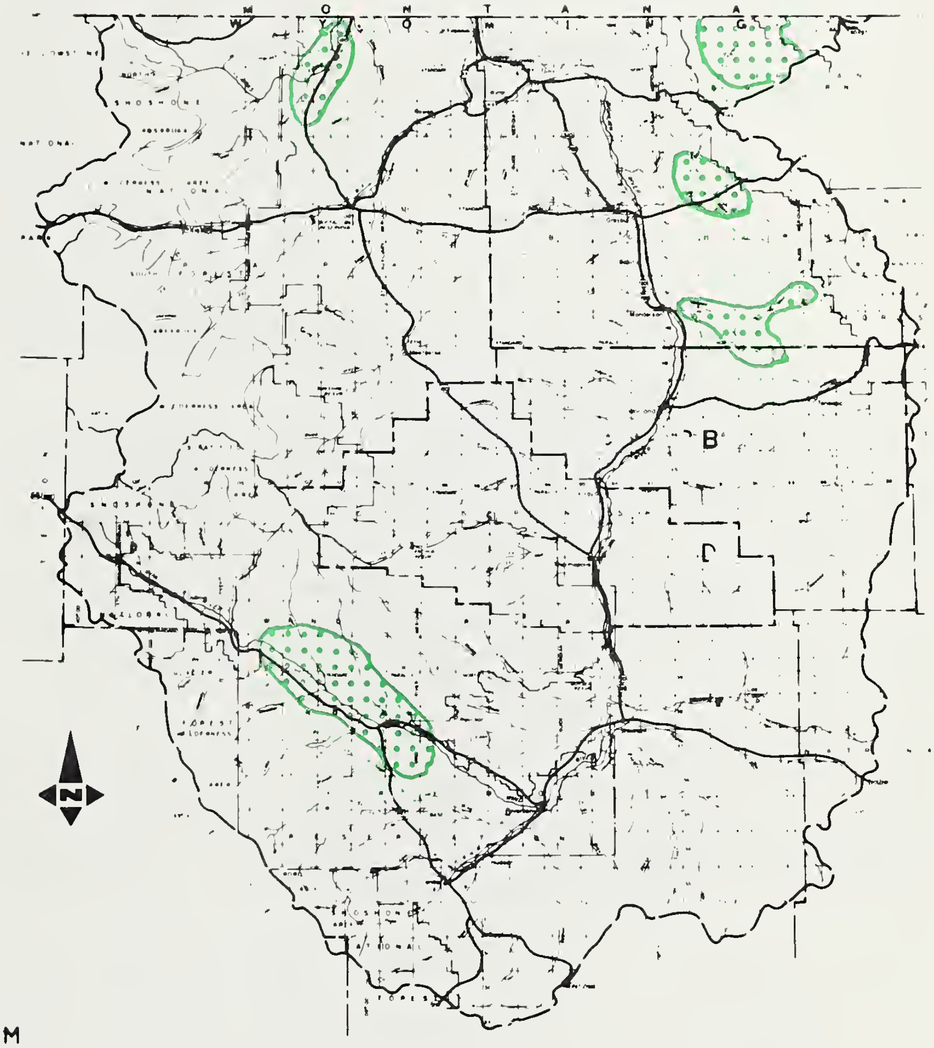
10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

SDA-SCS-PORTLAND, OREG 1975



TURKEY
HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-13

UPLAND GAME HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin
Comprehensive Framework Study

Table II-12--Area of big game ranges, 1969 1/

Species	Area inhabited 2/
	----1,000 acres---
Deer	8,764 3/
Elk	4,389
Moose	1,811
Bear	4,191
Antelope	8,742
Sheep	2,290
Mountain goat	100

1/ Includes portions of the Lander, Split Rock, and Ferris management areas.

2/ Data submitted for lands under the wildlife management jurisdiction of the Game and Fish Department (Indian and National Park lands are excluded in this table).

3/ Figure II-12 shows the entire area as deer habitat, but there are undelineated alpine areas, badland areas, urban areas, etc., which are not suitable habitat for deer.

Table II-13--Basic big game herd populations and estimated 1969 harvest

Species	Population	Estimated 1969 harvest
	----------------numbers----------------	
Deer	57,900	15,991
Elk	18,000	4,623
Moose	700	70
Bear	900	103
Antelope	13,100	3,094
Sheep & mountain goat	1,800	57

hungarian partridge, and chukar partridge.

The pheasant habitat is confined to the irrigated croplands located along creek and river bottoms, generally below 5,000 feet in elevation. Unless a program of habitat improvement is developed, pheasant habitat will deteriorate as fields become larger, cleaner farming is practiced, closed irrigation systems replace open ditches and reduce surface tailwater, and winter grazing of fields increases. Chukar habitat consists of semi-arid

Table II-14--Areas of upland game range and estimated 1969 harvest

Species	Area	Estimated 1969 harvest
	-1,000 acres-	--------numbers----------
Sage grouse	7,425	13,095
Chukar partridge	4,813	14,052
Hungarian partridge	4,375	3,762
Blue & Ruffed (mountain) grouse	3,706	410
Sharp-tailed grouse	N/A	N/A
Pheasant	803	25,767
Bobwhite quail	5	1/
Turkey	N/A	N/A
Cottontail rabbit	8,100	41,147

1/ No information available.

grazing lands and adjacent farm lands below 7,000 feet in elevation. Much of the area below 7,000 feet is also habitat for hungarian partridge. The best habitat is along creek and river bottoms in the farming areas. The balance of the partridge habitat is marginal. Blue and ruffed grouse live in mountainous, timbered areas. Blue grouse are found throughout the mountains. Ruffed grouse are limited to drainages along the face of the mountains.

Sagebrush areas below 7,000 feet are fair to good sage grouse habitat. The bobwhite habitat is restricted to a small portion of Big Horn County near the Yellowtail Wildlife Management Unit, and this is the only huntable population of bobwhites in Wyoming. Cottontail rabbits are found in all areas of the basin except in the mountains. Higher densities are found along the floodplains and benchlands of the major streams.

There are some turkey in the basin, but the marginal habitat cannot support a huntable population.

Waterfowl and wetland wildlife habitat

A complex of wetlands occurs in the basin and ranges from the margins of high mountain lakes to the margins of lower elevation lakes, reservoirs, streams, irrigation canals, drains, stock ponds, marshes, and irrigated lands.

Irrigated lands where grain crops are produced near open water areas are particularly important to waterfowl. Figure II-14 includes two maps showing major habitat areas and quality of habitat for ducks and geese. The maps in this figure were also taken from the Missouri River Basin Comprehensive Framework Study.

Bighorn sheep are native to the Bighorn Basin.

U.S. FOREST SERVICE PHOTO

Big game are plentiful in the basin.

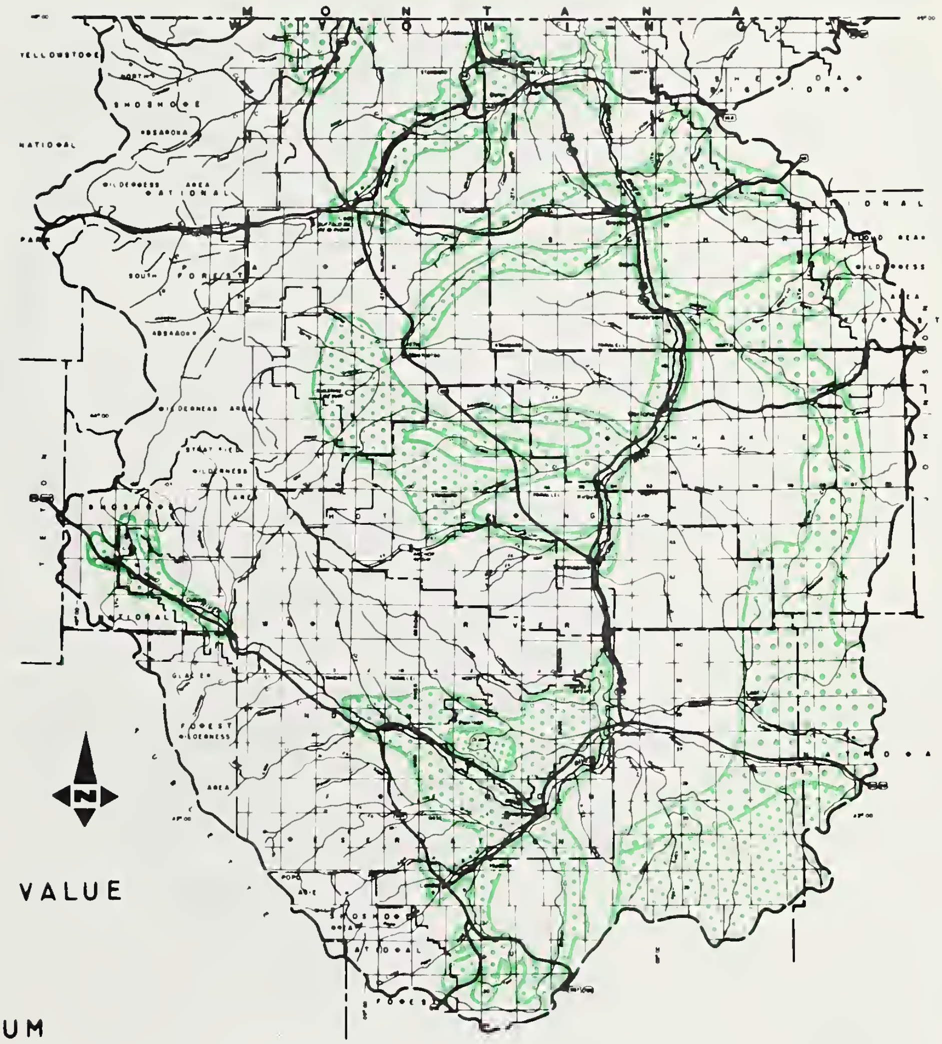
There is a wide variety of game birds in the basin.

Outfitting and packing are important activities.
USDA - FOREST SERVICE PHOTO

Fishing in a mountain lake can be a unique recreation experience. USDA - FOREST SERVICE PHOTO

The Buffalo Bill Museum at Cody is one of the most popular tourist stops in the basin.

PLATE 8



DUCK HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

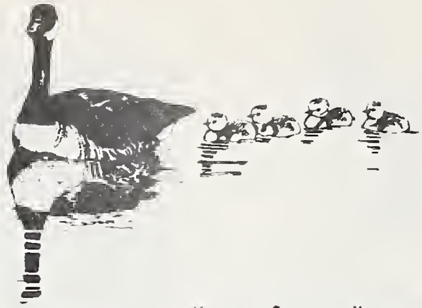
10 0 10 20 30 40 MILES

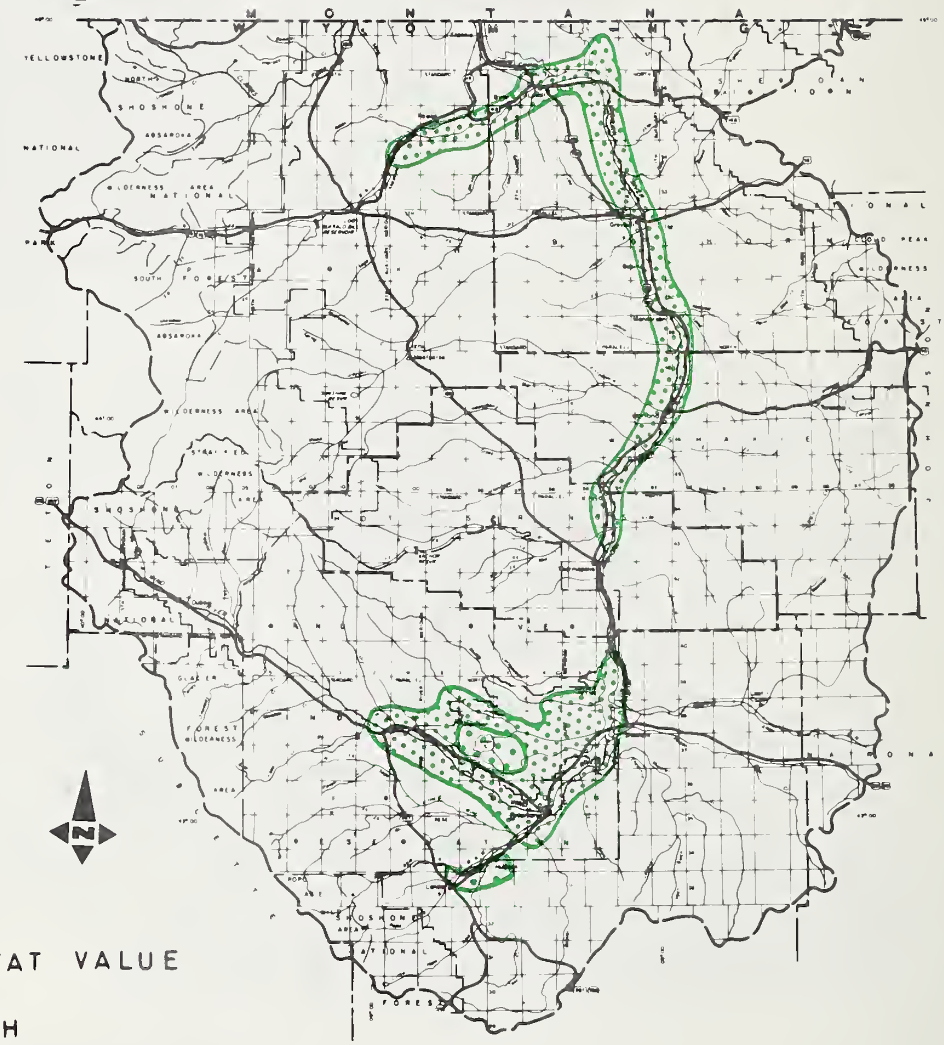
SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

Adopted from Missouri River Basin Comprehensive Framework Study

USDA-SCS-PORTLAND, OREG. 1975





GOOSE HABITAT VALUE

HIGH

MEDIUM

LOW

FIGURE II-14

WATERFOWL HABITAT

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 30 40 MILES

SCALE 1:2,100,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND, OREG 1975

Adopted from Missouri River Basin Comprehensive Framework Study

The Wyoming Game and Fish Commission owns 2,280 acres and administers 10,520 acres of federal lands near Riverton as a major wildlife management facility. Of the total area, about 6,300 acres are surface waters of Ocean Lake. The Yellowtail Wildlife Management Area of about 14,410 acres is managed by the Wyoming Game and Fish Commission under cooperative agreements with U. S. Department of Interior agencies. Marshes and water control facilities will be developed on about 1,000 acres in this area. Each year, more ranchers are constructing stock ponds; and many are used by waterfowl for brooding. There are presently about 1,700 stock ponds in the basin. Beaver ponds and mountain wetland areas are also attractive to waterfowl. Waterfowl game species found in the basin are canada geese, snow geese, mallards, and other ducks.

Non-game bird habitat

Numerous species of resident and migratory birds, other than those classed as game birds by Wyoming statutes, exist throughout the entire basin. Table II-15 is a list of both game and nongame species which may be seen in the basin.

In addition to the game bird classification, Wyoming statutes include three bird classes which are:

a. Predacious birds. This includes english sparrows, magpie, starling, and crow.

b. Protected birds. This includes pellican, swan, bittern, gull, falcon, hawk, owl, eagle, heron, kingfisher, and each insectivorous and song bird not herein otherwise specifically named or classified.

c. Migratory birds. This includes all migratory game birds defined and protected under federal law.

Management for all of the above species, with the exception of some migratory birds, is based on a general philosophy of offering legal protection to those species determined to need protection, participation in control programs involving certain predacious species, and giving consideration to nongame species in management programs for game species. The latter recommendation is based on the knowledge that improvement of habitat for game species will benefit most other species as well. Future programs will require more specific attention to nongame birds because of increased human population pressures on the natural habitat of all wildlife species.

Migratory birds are managed by cooperative arrangements between federal and state wildlife agencies, whereby some species are maintained in numbers sufficient to provide a harvestable surplus and others are totally protected.

Fisheries

The streams in the basin have been classified by the Wyoming Game and Fish Commission into five classifications based upon aesthetics, availability,

Table II-15--Birds seen in the Wind-Bighorn-Clarks Fork River Basin 1/

Name of Species	Code	Name of Species	Code	Name of Species	Code
Common Loon	(3m s)	Turkey Vulture	(2s)	Greater Yellowlegs	(3m)
Horned Grebe	(2m)	Goshawk	(3r)	Lesser Yellowlegs	(2m)
Eared Grebe	(2s)	Sharp-shinned Hawk	(3r)	Knot	(5m)
Western Grebe	(2s)	Cooper's Hawk	(3s)	Pectoral Sandpiper	(3m)
Pied-billed Grebe	(2s)	Red-tailed Hawk	(2r)	White-rumped Sandpiper	(4m)
White Pelican	(2m s)	Broad-winged Hawk	(5m)	Baird's Sandpiper	(2m)
Double-crested Cormorant	(2m s)	Swainson's Hawk	(2s)	Least Sandpiper	(2m)
Great Blue Heron	(2s)	Rough-legged Hawk	(2wv)	Dunlin	(4m)
Green Heron	(4m)	Ferruginous Hawk	(2s)	Long-billed Dowitcher	(2m)
Snowy Egret	(3m s)	Golden Eagle	(2r)	Stilt Sandpiper	(3m)
Black-crowned Night Heron	(2m s)	Bald Eagle	(2wv s)	Semipalmated Sandpiper	(3m)
American Bittern	(3a)	Marsh Hawk	(2r)	Western Sandpiper	(3m)
White-faced Ibis	(3m)	Osprey	(3m s)	Marbled Godwit	(3m)
Whistling Swan	(4m)	Prairie Falcon	(3r)	Hudsonian Godwit	(5m)
Canada Goose	(2r)	Peregrine Falcon	(4r)	Sanderling	(3m)
Snow Goose	(4m)	Pigeon Hawk	(4r)	Avocet	(2s)
Mallard	(2r)	Sparrow Hawk	(2s)	Black-necked Stilt	(4s)
Gadwall	(2s)	Sage Grouse	(2r)	Wilson's Phalarope	(1s)
Pintail	(2s)	Ring-necked Pheasant	(2r)	Northern Phalarope	(2m)
Green-winged Teal	(2s)	Chukar	(2r)	Herring Gull	(4m)
Blue-winged Teal	(2s)	Gray Partridge	(r)	California Gull	(2s)
Cinnamon Teal	(2s)	Sandhill Crane	(2s)	Ring-billed Gull	(2m)
American Widgeon	(2s)	Virginia Rail	(3s)	Franklin's Gull	(2m)
Shoveler	(2s)	Sora	(2s)	Bonaparte's Gull	(3m)
Redhead	(2s)	American Coot	(1s)	Sabine's Gull	(4m)
Ring-necked Duck	(3m)	Semipalmated Plover	(3m)	Forster's Tern	(2m)
Canvasback	(2m s)	Piping Plover	(4m)	Common Tern	(4m)
Greater Scaup Duck	(4m)	Snowy Plover	(5m)	Caspian Tern	(3s)
Lesser Scaup Duck	(2s)	Killdeer	(1s)	Black Tern	(2s)
Common Goldeneye	(2wv)	Mountain Plover	(3s)	Mourning Dove	(1s)
Barrow's Goldeneye	(2m s)	American Golden Plover	(5m)	Black-billed Cuckoo	(2s)
Bufflehead	(2m s)	Black-bellied Plover	(3m)	Screech Owl	(4s)
Oldsquaw	(5m)	Ruddy Turnstone	(4m)	Horned Owl	(2r)
Harlequin Duck	(3s)	Common Snipe	(2r)	Snowy Owl	(4wv)
White-winged Scoter	(4m)	Long-billed Curlew	(2s)	Burrowing Owl	(3s)
Surf Scoter	(4m)	Whimbrel	(3m)	Long-eared Owl	(3r)
Ruddy Duck	(2s)	Upland Plover	(2s)	Short-eared Owl	(2r)
Hooded Merganser	(3m)	Spotted Sandpiper	(2s)	Saw-whet Owl	(4m)
Common Merganser	(2r)	Solitary Sandpiper	(2m)	Poor-will	(2s)
Red-breasted Merganser	(3m)	Willet	(2s)	Common Nighthawk	(2s)
White-throated Swift	(2s)	House Wren	(2s)	Red-winged Blackbird	(1s)
Broad-tailed Hummingbird	(2s)	Winter Wren	(4m)	Bullock's Oriole	(2s)
Rufous Hummingbird	(3m)	Long-billed Marsh Wren	(2s)	Rusty Blackbird	(4m)
Calliope Hummingbird	(2s)	Rock Wren	(1s)	Brewer's Blackbird	(2s)
Belted Kingfisher	(2r)	Mockingbird	(3r)	Common Grackle	(2s)
Yellow-shafted Flicker	(3r)	Catbird	(2s)	Brown-headed Cowbird	(2s)
Red-shafted Flicker	(2r)	Brown Thrasher	(2s)	Western Tanager	(2s)
Red-headed Woodpecker	(3s)	Sage Thrasher	(2s)	Black-headed Grosbeak	(2s)
Lewis' Woodpecker	(2s)	Robin	(1r)	Blue Grosbeak	(4s)
Yellow-bellied Sapsucker	(2s)	Hermit Thrush	(3s Mts)	Indigo Bunting	(4s)
Hairy Woodpecker	(2r)	Swainson's Thrush	(2s Mts)	Lazuli Bunting	(2s)
Downy Woodpecker	(2r)	Veery	(2s)	Evening Grosbeak	(2wv)
Eastern Kingbird	(2s)	Mountain Bluebird	(2s)	Caccin's Finch	(2r)
Western Kingbird	(2s)	Townsend's Solitaire	(2r Mts)	House Finch	(2r)
Say's Phoebe	(2s)	Golden-crowned Kinglet	(2s Mts)	Pine Grosbeak	(3r Mts)
		Ruby-crowned Kinglet	(2s Mts)		
Traill's Flycatcher	(2s Mts)	Water Pipit	(2s A)	Gray-crowned Rosy Finch	(2wv 2s)
Least Flycatcher	(2s)	Bohemian Waxwing	(2wv)	Black Rosy Finch	(2s Mts)
Dusky Flycatcher	(2s)	Cedar Waxwing	(2s)	Common Redpoll	(2wv)
Western Flycatcher	(2s)	Northern Shrike	(2wv)	Pine Siskin	(2s)
Western Wood Pewee	(1s)	Loggerhead Shrike	(2s)	American Goldfinch	(2s)
Olive-sided Flycatcher	(3s Mts)	Starling	(2r)	Red Crossbill	(2r Mts)
Horned Lark	(1r)	Solitary Vireo	(3s)	White-winged Crossbill	(4m)
Violet-green Swallow	(2s)	Red-eyed Vireo	(2s)	Green-tailed Towhee	(2s Mts)
Tree Swallow	(2s)	Warbling Vireo	(1s)	Rufous-sided Towhee	(2s)
Bank Swallow	(3s)	Tennessee Warbler	(4m)	Lark Bunting	(1s)
Rough-winged Swallow	(2s)	Orange-crowned Warbler	(2s)	Savannah Sparrow	(2s)
				Grasshopper Sparrow	(2s)
Barn Swallow	(3s)	Nashville Warbler	(4m)	Vesper Sparrow	(1s)
Cliff Swallow	(1s)	Yellow Warbler	(1s)	Lark Sparrow	(2s)
Purple Martin	(4s)	Myrtle Warbler	(2m)	Slate-colored Junco	(3wv)
Gray Jay	(2r Mts)	Audubon's Warbler	(2s)	Oregon Junco	(2r)
Steller's Jay	(2r Mts)	Black-throated Gray Warbler	(2s)	Gray-headed Junco	(2s Mts)
Black-billed Magpie	(1r)	Townsend's Warbler	(3m)	Tree Sparrow	(2wv)
Common Raven	(2r Mts)	Blackpoll Warbler	(4m)	Chipping Sparrow	(2s Mts)
Common Crow	(2r)	Northern Waterthrush	(3m)	Brewer's Sparrow	(2s)
Pinon Jay	(2r)	MacGillivray's Warbler	(2s Mts)	Harris' Sparrow	(3wv)
Clark's Nutcracker	(2r Mts)	Yellowthroat	(2s)	White-crowned Sparrow	(2s Mts)
Black-capped Chickadee	(2r)	Yellow-breasted Chat	(2s)	White-throated Sparrow	(3m)
Mountain Chickadee	(2r)	Wilson's Warbler	(2s Mts)	Fox Sparrow	(2s 3wv)
White-breasted Nuthatch	(2r)	American Redstart	(3s)	Lincoln's Sparrow	(2s Mts)
Red-breasted Nuthatch	(2r)	House Sparrow	(1r)	Song Sparrow	(2r)
Pygmy Nuthatch	(3ri)	Bobolink	(3s)	McCown's Longspur	(2s)
Brown Creeper	(2r)	Western Meadowlark	(1s)	Lapland Longspur	(3m)
Water Ouzel	(2s Mts)	Yellow-headed Blackbird	(2s)	Snow Bunting	(3wv)

KEY TO CODE

1 - abundant
2 - common
3 - uncommon
4 - rare
5 - casual

m - migrant
s - summer resident
r - resident
wv - winter visitant
f - formerly
i - irregular

Mts - mountains
A - alpine zone

1/ Prepared by Dr. Oliver Scott in affiliation with the Murie Audubon Society, Casper, Wyoming.

and productivity. The total stream miles, as well as minimum miles, were determined for each stream which was actually producing or providing fishery and are listed in table II-16 and shown in figure II-15.

There are more than 4,200 miles of streams that have been classified. The stream habitat varies from small streams with beaver ponds to large flowing streams. As shown on the map, class 1 represents fisheries of national importance, class 2 of statewide importance, class 3 of regional importance, class 4 of local importance, and class 5 are often incapable of sustaining a fishery. The Wind River below Boysen Dam is the only stream with a class 1 designation. Most of the stream miles are classed as 2, 3, and 4 waters. The class 5 streams have little fishery potential or fishing pressure.

Class 1 streams are considered top quality trout streams. As one progresses from class 1 to class 5 streams, the quality of the streams diminishes. Over 70 percent of the stream mileage is on public lands, and the rest on private lands.

Lentic waters producing or providing a fishery have a surface area of about 61,341 acres. These lakes, reservoirs, and ponds were not classified like the streams but were categorized by seven types and listed by county in table II-17.

Streams presently provide about 26,300 fisherman days of fishing per year while lakes, ponds, and reservoirs provide about 103,500 days. Existing streams could sustain about 80,000 days per year and existing ponds, lakes, and reservoirs about 406,000.

Fur animal habitat

Beaver, mink, muskrat, otter, martin, red fox, skunk, weasel, raccoon, jackrabbit, badger, coyote, bobcat, lynx, mountain lion, and limited numbers of fisher and wolverine are fur animals that may be found in portions of the basin.

Table II-16--Summary of stream miles of fishery

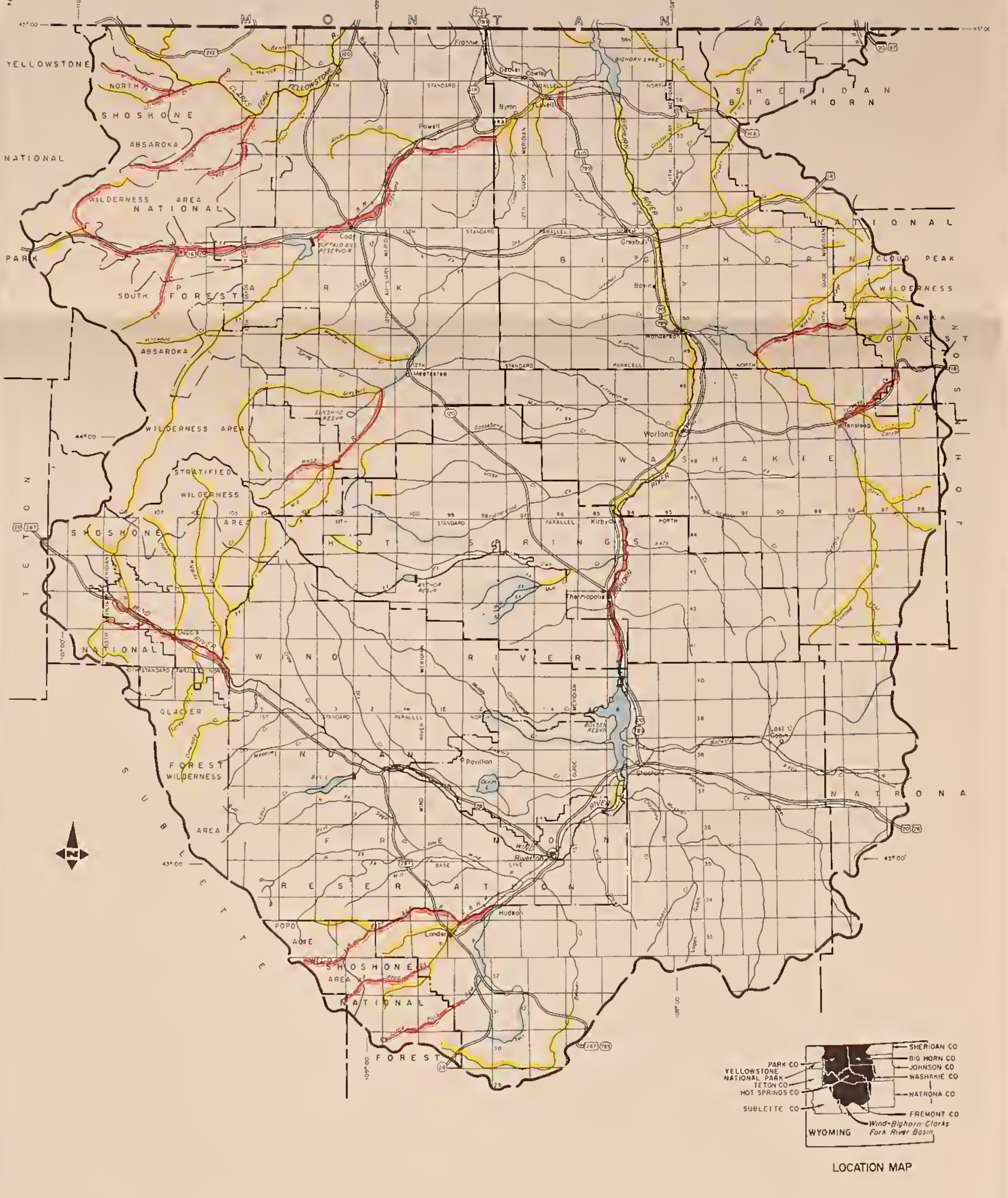
County 1/	Class 1	Class 2	Class 3	Class 4	Class 5	Total
	---	---	minimum miles	---	---	---
Fremont	3.0	131.8	893.2	699.5	46.5	1,774.0
Big Horn	0.0	19.5	442.3	102.0	13.9	577.7
Hot Springs	0.0	30.7	37.5	170.3	5.3	243.8
Park	0.0	251.4	883.5	257.3	12.2	1,404.4
Washakie	0.0	15.2	178.2	57.7	3.3	254.4
Total	3.0	448.6	2,434.7	1,286.8	81.2	4,254.3

1/ Gross areas for counties may include some areas outside the basin.

Table II-17--Lakes, reservoirs, and ponds with fisheries

County 1/	Natural lakes		Reservoirs		Farm ponds by type of fish			Total
	Alpine	Lowland	Alpine	Lowland	Cold water	Warm water	Mixed	
	number							
Fremont	518	17	9	26	56	5	0	631
Big Horn	67	2	8	13	12	18	0	120
Hot Springs	1	0	0	5	10	7	2	25
Park	155	11	7	20	30	6	1	230
Washakie	0	0	1	11	18	6	2	38
Total	741	30	25	75	126	42	5	1,044

1/ Gross areas for counties may include some areas outside the basin.



STREAM FISHERY CLASSIFICATION

Premium trout waters—fisheries of national importance

Very good trout waters—fisheries of statewide importance

Important trout waters—fisheries of regional importance

Low production waters—fisheries frequently of local importance but generally incapable of sustaining substantial fishing pressure

FIGURE II-15

STREAM FISHERY CLASSIFICATION

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

SCALE 1:1,000,000

M7-N-22780M

USDA-SCS-PORTLAND, OREG. 1974

Rare and endangered species

Mammal, bird, and fish species which may be found in the basin that are threatened or which are limited in numbers but for which status is still undetermined are listed below in common names:

Status	Class	Species
Rare	Mammal	Spotted bat Grizzly bear
	Bird	Prairie falcon Greater sandhill crane
	Fish	Grayling Silvery minnow
Threatened	Mammal	Black-footed ferret
	Bird	American peregrine falcon
	Fish	Shovelnose sturgeon Goldeye Sturgeon chub
Status undetermined	Mammal	Pine martin Fisher Wolverine Canada lynx
	Bird	Ferruginous hawk American osprey

Compiled from:

Rare and Endangered Fish and Wildlife of the United States. Resource publication 34, Bureau of Sport Fisheries and Wildlife, July 1966.

Wyoming Fishes. Baxter, George T. and James R. Simon, 1970.

Threatened Fishes of the United States. Miller, Robert Rush, Transactions of the American Fisheries Society, Vol. 101, No. 2, April 1972.

Threatened Wildlife of the United States, Resource Publication, Bureau of Sport Fisheries and Wildlife, March 1973.

Recommendations of Wyoming Game and Fish Department.

RECREATIONAL FEATURES

Outstanding natural and scenic resources offer great opportunities for outdoor recreation in the basin. The mountainous areas which surround the basin are the principal base of recreational activity because of their pleasant summer climate, scenery, lakes and streams, and wildlife. Scattered glacial lakes and mountain streams provide spectacular scenery and cold water fishing. Federal and state highways, county, forest, and private roads provide access to some of the scenic areas not included in wilderness or primitive areas. Within the lower areas of the basin are scenic desert formations, larger rivers, lakes, and reservoirs such as Boysen, Bighorn, and Buffalo Bill. Private irrigated lands add greenery to the desert landscapes. Other private lands serve as a base for recreational activities on public lands as they are used for "dude" ranches, lodges, summer cottages, campgrounds, and service areas.

Some of the more important of outdoor recreation uses are camping, hunting, fishing, hiking, and packing, sight-seeing, rock hounding, snow-mobiling, skiing, visits to historic sites, and sites for summer cottages.

About 6,000 miles of streams in the basin provide opportunities for fishing, tubing, boating, canoeing, and other associated sports. There are about 70,000 surface acres of lakes and reservoirs which are used for fishing as well as other water sports.

QUALITY OF THE NATURAL ENVIRONMENT

General

The low population density of about three persons per square mile has tended to preserve much of the quality of the environment in a semi-native state. However, the environment has been altered, to varying degrees, by activities of man. Past grazing by livestock and wildlife has been excessive for the resource in some areas and caused an increase in the amount of big sagebrush. It is generally considered that pure stands of big sagebrush do not provide quality watersheds. About a half million acres of irrigated cropland have been developed along mountain streams and on desert benches. Inefficient irrigation practices which result in large amounts of waste water have caused erosion of small streams and waterways and deposited sediment into the larger rivers and man-made lakes.

These irrigation diversions also affect fish habitat by reducing natural streamflows. Conversely, irrigated lands have encouraged increased numbers of some species of wildlife and allowed introduction of some exotic species such as the pheasant.

Recreational demands by hunters, fishermen, and tourists have affected environmental quality in more remote regions. Mining and oil field development have affected landscapes and streams.

Forests are very important components of the natural environment.

Forested lands are quite stable, and, unless disturbed, have low rates of erosion and sediment production.

Some of the forested land has been harvested for wood products. Harvest is necessary to keep the forest in good condition to provide wildlife habitat, recreation, wood products, good winter snowpack development, and the release of good quality streamflows.

Water quality

In the planning of the use of water resources, consideration must be given to water quality. Every water use has definite water quality requirements. Whenever water quality deteriorates below the minimum requirement of any use, the use is lost or made more expensive by the need for water treatment. The aim of the State Water Quality Program is to maintain the quality of the state waters such that true multiple water uses can be maintained.

The quality of most of the waters of this river basin can be described as good. Excellent quality is found in the high mountains where most of the basin's water originates. Remoteness and lack of developed access has protected water quality in these mountainous forest watersheds. However, there is a gradual decline in quality as the water moves downstream.

This decrease in quality is largely the result of natural conditions. Runoff from lower elevation lands carries much higher concentrations of minerals, sediments, and other pollutants than runoff from the mountain watersheds.

While there are places on the streams, notably near towns and a few feedlots where biologic pollutants are discharged into streams, we have no record of significant adverse effects at present. Dissolved oxygen levels are apparently satisfactory at all locations where sampling is conducted on a regular basis. The major pollutants of water in the basin are suspended sediments and dissolved solids. Table II-18 is a list of the average annual concentration of dissolved solids at locations where these data are measured and published by the U. S. Geological Survey.

Concentrations of dissolved solids (TDS) and suspended sediments vary greatly during the year. For example, in water year 1966, TDS in the Little Wind River near Riverton varied from 290 mg/l on May 15 to 842 on August 20 and 874 on March 18. The suspended sediment in Fivemile Creek near Shoshoni in the same year varied from 180 mg/l on November 7 to 3,900 mg/l on April 16. Badwater Creek at Lysite varied from 68 mg/l on January 7 to 38,000 mg/l on June 23. Suspended sediment loads are not widely measured in the basin and are not listed here for that reason. The recommended maximum concentration of total dissolved solids in private or semi-public water supplies is 1,000 mg/l when no other water is available and for livestock up to 2,500 mg/l is acceptable.

Table II-18--Average annual concentration of total dissolved solids

Gaging location	Total dissolved solids
	-------- mg/l ---------
Wind River near Dubois	105
Wind River at Riverton	205
Little Wind River near Riverton	390
Fivemile Creek near Shoshoni	1,240
Wind River below Boysen	460
Bighorn River at Lucerne	520
Bighorn River at Neiber	555
Bighorn River at Worland	600
Nowood River at Manderson	470
Greybull River near Basin	625
Shell Creek near Greybull	645
Bighorn River at Kane	620
Shoshone River below Buffalo Bill Reservoir	225
Shoshone River near Lovell	465
Shoshone River at Kane	695
Clarks Fork River near Chance	107

Compiled from:
Water resource records for Wyoming, part 2, water quality records, U. S. Geological Survey. Data furnished by Wyoming Water Planning Program.

Reservoirs affect the concentration of TDS adversely. Evaporation from the reservoir causes increased concentrations. They generally have a significant beneficial effect in reducing concentrations of suspended

sediments. This effect at Boysen Reservoir is important to the class 1 blue ribbon trout stream fishery for 3 miles downstream.

Irrigation return flows are important contributors of suspended sediment and TDS loads to the lower streams of the basin. Much of the increase of TDS in the Shoshone River from Lovell to Kane is the result of irrigation return flows.

Natural mineralized hot springs are also important contributors of dissolved solids. Much of the increase in TDS in the Bighorn River from Boysen to Lucerne comes from Thermopolis Hot Springs. These are claimed to be the largest such springs in the world. Hot springs on the Shoshone River below Buffalo Bill Dam are important as contributors of TDS. Saline waters from oil wells also contribute dissolved solids to the stream system of the basin.

Description of the quality of the forest environment

Air quality has recently gained increased public attention because the reservoir of air which supports life has steadily deteriorated. Forests influence air quality more than any other land ecosystem. Trees filter dust, ash, and other solids from the air; and they absorb gaseous pollutants such as sulphur monoxide, ozone, and carbon monoxide. Most importantly they act as great users of carbon dioxide. The purity of air in the basin is due in no small part to the forested highlands which enclose the developed valleys and plains.

Ugly is a word that was never written for the Wind-Bighorn-Clarks Fork Basin. From the kaleidoscope of pastels of the desert badlands to the rich cushion of forested areas of the surrounding mountains, one word suffices--spectacular! Except for a few man-made nicks around the edges, a major portion of the forested areas surrounding the basin are primeval and virgin. This is "back-country USA." An infant by geological standards, the land forms are characterized by jagged, soaring peaks and wild, clear, white water streams noisily plunging through the abyss of steep-walled inaccessible canyons. It is an area of rare, priceless, undefiled beauty. Much of the high mountain area is protected by designation as Wilderness, Primitive Area, or National Park. Even those areas of unclassified forested lands remain relatively free of human impact. Low population, inaccessibility, tradition, and lack of demand are the more important reasons why development of natural resources has been kept at the minimum. Any planned development in the Wind-Bighorn-Clarks Fork River Basin should recognize scenic values as one of the most critical environmental concerns.

As important as these physical attributes are, they may not be the basin's most important contribution to environmental quality. Man's environment includes land, water, and air. It also includes sociological institutions, physical, and structural factors such as buildings, traffic, cities, and all living organisms, including man.

The spiritual needs of man are difficult to describe and impossible to separate from the varied aspects of life. We do know that a chance to rest and enjoy a natural environment such as the mountainous wildlands, forests, and badlands of the basin can help contribute to mental and physical health. This type of environment offers unique opportunities to enjoy quietness, solitude, and freedom from the confusion and abstraction of everyday life.

III. ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Man has lived in the Wind-Bighorn-Clarks Fork Basin since prehistoric time. The Medicine Wheel, on Medicine Mountain in the Big Horns, commands a tremendous view of the Bighorn Basin. The wheel is formed of stones laid side by side. They form a circle 78 feet in diameter. Six rock cairns about 2½ feet high are around the wheel. Five of the cairns face inward toward the center of the wheel; the sixth faces outward to the rising sun. Near Meeteetse, on the Greybull River, an arrow about 30 feet long, also formed by laying rocks side by side, points toward the Medicine Wheel. The original purpose of these archeological ruins is not known.

Excavations of Mummy Cave near Cody on the North Fork of the Shoshone River indicate the cave was occupied as long ago as the year 7280 B.C. Mummy Joe, for whom the cave is named, was wrapped in a sheepskin garment. A salvaged piece places his burial in the year 734 A.D. or about 1,238 years ago. All of the cultural layers give evidence that young mountain sheep were the principal food supply for the cave dwellers.

Indian tribes active in the basin were the Sioux, Crow, Cheyenne, Arapahoe, Shoshone, and the Sheepeaters. They ranged along the foothills of the mountains, using the basin primarily as hunting grounds during the summer and fall. The Shoshone occasionally wintered near the Wind River. The Sheepeaters appear to have been the only Indians in residence.

John Coulter, a mountain man and trapper, is generally credited with being the first white man into the basin. About 1809 he was near the present town of Laurel, Montana, with the Manuel Lisa expedition when he was sent out alone to drum up business with the Indians. He went up the Shoshone River to about Cody and described the geyser activity at the mouth of the canyon there. He went north into Sunlight Basin and then east and south to the west slope of the Big Horns. He was near Thermopolis and crossed south into the Lander-Riverton area. He went northwest out of the basin over Togwotee Pass into Jackson Hole.

Ashley's fur traders came down the Wind River in 1827. Captain L. E. Bonneville's rendezvous of 1833 was on the Popo Agie, and Nathaniel Wyeth came through the area the same year. In 1860 Jim Bridger, leading the War Department expedition into Yellowstone Park, went through parts of the basin.

Cattle were brought into the Wind River Valley in 1869, and farming started on a tributary to Red Canyon Creek. Agricultural settlement on the Wind River continued. At the same time large herds of cattle were being brought into the basin forming the first cattle ranches. Commissary activities associated with the ranch headquarters were the start of early communities. The Embar on Owl Creek, the Pitchfork at Meeteetse,

Otto Franck at Otto, Henry Lovell near Kane, and John Luman at Hyattville were early ranches and ranchers.

In 1868 the settlers in the Wind River Valley by formal action set forth the boundaries of Fremont County and ordered the town of Lander to be laid out. Fremont County became the first county in the state to be broken out of the first five counties, and Lander became the first town in the basin. The Federal Government had just signed the Treaty of 1868 with the Shoshone Indians and moved them from the Green River country to the present reservation. The settlers were very upset. Their political action seems to have been an attempt to assert states' rights, rather than a need for local government. Big Horn County was the next county formed. The Bighorn River was the east boundary when the territorial government proposed to carve Big Horn County from parts of Carbon and Sweetwater Counties in 1890. A territorial requirement was a population of 1,500 people within the county. The new county was not able to meet this requirement. In 1896 the legislature moved the boundary from the river to the crest of the Big Horn Mountains. This gave them enough people, and Big Horn County became an entity. Park County in 1909 and Hot Springs and Washakie Counties in 1911 were created from the original Big Horn County.

The Bridger Trail, an alternate to the Bozeman Trail, came north into the Bighorn Basin over Sioux Pass. It came down to the Bighorn River near the mouth of Owl Creek. It roughly paralleled the Bighorn to the Greybull River, went up the Greybull River, over to the Shoshone River, and north to the Yellowstone River.

Daily mail came from Red Lodge to Meeteetse on the Red Lodge Stage. From Meeteetse the stage east was to Fenton, Otto, Bonanza, and Hyattville. South of Meeteetse the road went through Embar on Owl Creek to Ft. Washakie. Mail came from the east through Buffalo, up Clear Creek to Hazelton, down to Ten Sleep, and then north to Hyattville. Another route was from Sheridan over the Big Horns to Spanish Point and down to Hyattville and Bonanza. By 1911 when state highways were designated, the present network of roads was largely established.

The Burlington Railroad was extended south from Toluca, Montana, in 1905. It reached Cowley in 1906. By 1908 Thermopolis had railroad service. The Wyoming and Northwestern Railroad Company built west from Casper to Shoshoni in 1906 and from Shoshoni to Lander in 1907. Surveyors from the Chicago and Northwestern Railroad Company surveyed a line through the Wind River Canyon; but work was stopped at this point, and Lander became the western terminus of the railroad. It wasn't until 1913 when the Burlington Railroad used the earlier surveys and built through the Wind River Canyon that the basin had through train service.

The Wind River Valley was the first agricultural center in Wyoming. In 1883 farmers in the valley harvested 50,000 bushels of grain, receiving star billing in the Governor's annual report. During the period 1870 to 1900 development in the basin was slow. Ranching had settled in with large ranches and small communities along the foot of the mountains. In addition to Lander, the present towns of Thermopolis, Basin, and Cody had been established. The mining activity at South Pass had essentially stopped,

An old tepee ring near the present Boysen Reservoir. Man inhabited portions of the basin as long as 9000 years ago.

The search for gold brought the first settlers into and around the basin.

PLATE 9

and no new discoveries had been made. In 1894 the Carey Act was passed, allowing the development of federal lands by construction of irrigation works. At about the same time Mormon colonies from Salt Lake started moving into the basin. By 1905 the Cody Canal at Cody, the Bench Canal at Emblem, and the Bighorn Canal at Worland were developing lands under the Carey Act. By 1907 more than 300,000 acres in the Wind-Bighorn-Clarks Fork River Basin had been segregated for development. A population explosion from 1900 to 1910 more than doubled the population. The new communities of Riverton, Worland, Lovell, Byron, and Powell were started, and the present system of counties was formed.

GENERAL DESCRIPTION

Numerous factors have influenced the economic development of the Wind-Bighorn-Clarks Fork Basin. Population, employment, and income are the more important economic indicators affecting the area as it exists currently. In this chapter these elements are described historically, measured in terms of present status, and projected to the years 1980, 2000, and 2020. Other economic and social factors such as migration, ethnic groups, and education are also discussed.

Much of the information about economic activity and social characteristics was obtained from published materials. Data from secondary sources are generally not available for areas smaller than counties or groups of counties. Therefore, the five counties in the basin believed to be most representative of the basin are used as the geographic unit for economic study. The total area of these counties is slightly larger than the river basin area in Wyoming, but no major population centers were added or deleted by using this delineation. The five counties are: Big Horn, Fremont, Hot Springs, Park, and Washakie.

Population

The population of the study area remained nearly constant from 1920 to 1930, increased about 10,000 persons for each of the next three decades, and then decreased slightly from 1960-70. The 1970 population count was 68,407. Fremont, Park, and Washakie Counties account for nearly all of the population growth during the past 50 years. Total population for the five counties is listed in table III-1. Basin population is predominantly rural, although the residents are becoming more urban-oriented each year. This trend toward urbanization reflects a migration from rural agricultural sectors and is characteristic of most sections of the United States. In 1970 nearly 49 percent of the area population lived in urban areas as compared to 21 percent in 1940. One county, Big Horn, had no urban population in 1970. None of the communities is large enough to be classed as a Standard Metropolitan Statistical Area. Riverton, Lander, Cody, and Worland are the largest towns each having a popuation over 5,000. All but Worland showed a sizeable gain during the past decade. Population by rural and urban categories is listed in table III-2.

Table III-1--Total population of Wyoming counties

Counties	1920	1930	1940	1950	1960	1970
Big Horn	12,105	11,222	12,911	13,176	11,898	10,202
Fremont	11,820	10,490	16,095	19,580	26,168	28,352
Hot Springs	5,164	5,476	4,607	5,250	6,365	4,952
Park	7,298	8,207	10,976	15,182	16,874	17,332
Washakie	3,106	4,109	5,858	7,252	8,883	7,569
Total	39,493	39,504	50,447	60,440	70,188	68,407

Source: U.S. Census of Population

Table III-2--Population by rural and urban categories

Category	1940	1950	1960	1970
Urban	10,380	24,747	30,366	33,206
Rural farm	22,283	18,759	14,032	10,612
Rural non-farm	17,784	16,934	25,790	24,589
Total	50,447	60,440	70,188	68,407

Source: U.S. Census of Population

In 1970 there was a total of 23 incorporated communities, varying in size from 25 persons in Lost Cabin to 7,995 in Riverton. Nearly all of the nonfarm population growth since 1940 has occurred in towns larger than 2,500 persons. In table III-3, incorporated towns are listed according to their size class in 1970, thus revealing what changes have taken place during the 30-year period.

The rural orientation of the area is also revealed by population density. There are less than three perons per square mile compared with over three per square mile for Wyoming and about 57 per square mile for the United States. Fremont and Hot Springs Counties contain the Wind River Reservation which is the only Indian Reservation in Wyoming. Two tribes

Those who found no gold began to settle the land. The sod-covered log house was the standard homesteader's residence.

This picture of a tar paper shack and serious wind erosion was taken in 1937 during the settlement of the Riverton Project.

In 1943 the tar paper shack remained, but a planted windbreak had helped heal the land.

When repayment problems developed on a portion of the Riverton Reclamation Project, the land was purchased by the government; and some settlers abandoned their homes.

An "average" farmstead on an irrigated farm on the Riverton Reclamation Project. The windbreak of planted trees protects homes and reduces erosion.

PLATE 11

Table III-3--Population of towns by size class

Size class 1/	Number of towns	Year 1940	1950	1960	1970
Less than 500	12	2,485	2,683	3,132	2,888
500-999	2	638	1,170	1,340	1,460
1,000-2,499	3	5,102	5,990	6,056	5,469
2,500-5,000	2	4,370	6,674	8,695	7,870
Over 5,000	4	10,380	15,565	21,671	25,336
Total	23	22,975	32,082	40,894	43,023

1/ Population of towns in 1970 determined size class for all years shown above.

Source: U. S. Census of Population

(the Shoshone and the Arapahoe) are located here. At the present time, 6 percent of the total population and 10 percent of the rural people are Indian. The number of resident Indians increased from 3,517 in 1960 to 4,044 in 1970. Nearly 90 percent have a rural status.

From 1960 to 1970, migration patterns have influenced population changes in the study area by a greater amount than birth and death rates. During this decade the five counties had a net out-migration of a total of 10,464 people. Out-migration has had a profound impact on the farm population. Off-farm and out-of-the-basin employment opportunities, coupled with decreased agricultural labor requirements and increased farm efficiency, have resulted in more nonfarm residents and increased out-migration. Net migration rates for the past three decades are shown in table III-4.

Numerous side effects result from population migration. Some age groups are influenced more than others. A large proportion of the losses are occurring in the productive age groups; i.e., productive in terms of economic and reproductive capacities. Changes in the composition of the population from 1960 to 1970 are shown in figure III-1. The population has undergone a maturing process in terms of age distribution.

The Indian population as a whole is quite young compared to the non-Indians. The median age of Indians in the area in 1970 was 20.5 years compared with 27.8 for all inhabitants. More than 60 percent of the Indian population is under 25 years of age as contrasted to 46 percent

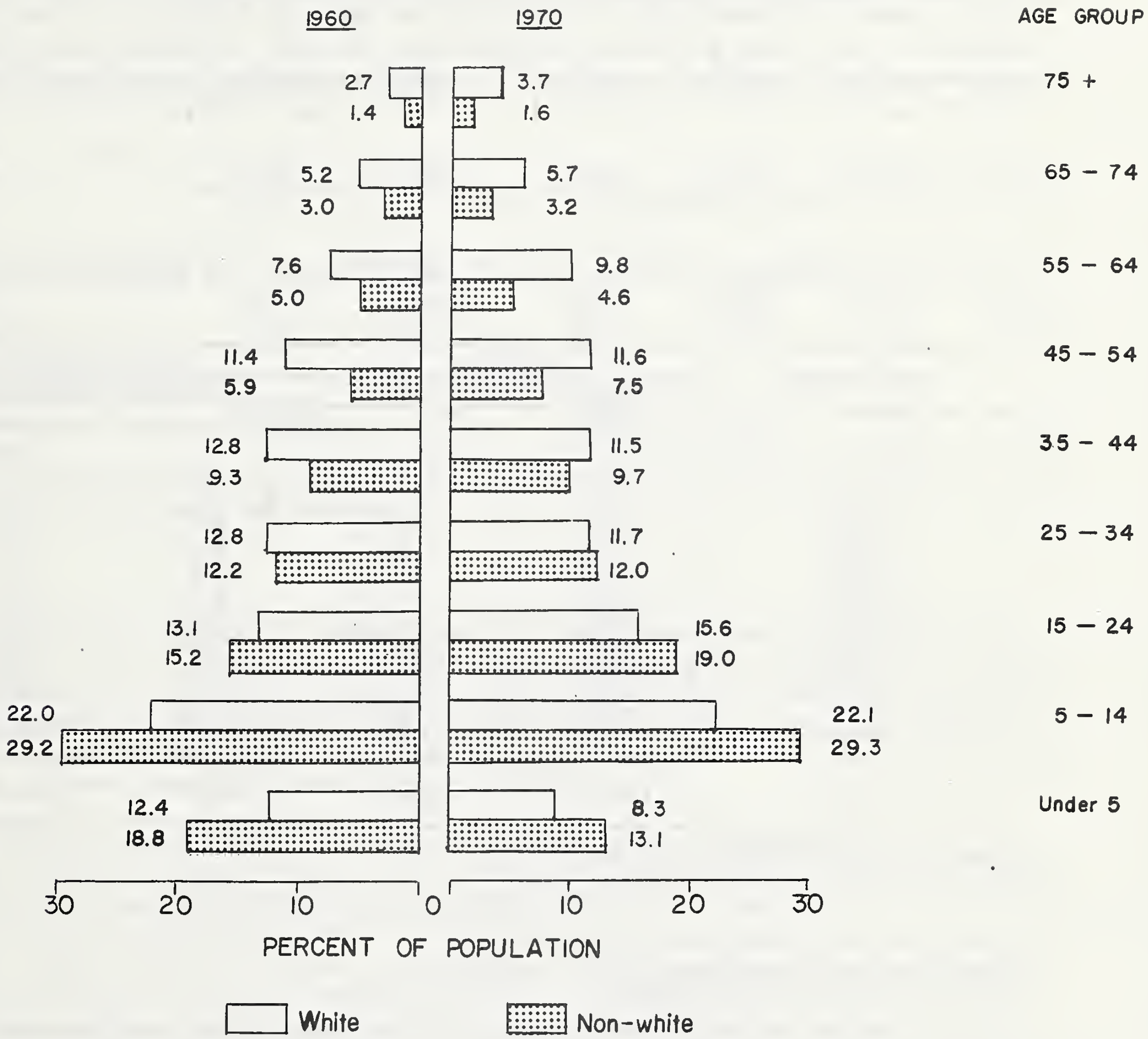
Table III-4--Components of population change, 1940-1970

Component	Big Horn No.	Big Horn Percent	Fremont No.	Fremont Percent	Hot Springs No.	Hot Springs Percent	Park No.	Park Percent	Washakie No.	Washakie Percent	Total No.	Total Percent
1940 population	12,911		16,095		4,607		10,976		5,858		50,447	
1940-50:												
Natural increase 1/	2,333		2,350		652		2,722		1,137		9,194	
Net migration 2/	-2,068	-16.0	1,135	+7.1	-9	-0.2	1,484	+13.5	257	+4.4	799	+1.6
Population change	265		3,485		643		4,206		1,394		9,993	
1950 population	13,176		19,580		5,250		15,182		7,252		60,440	
1950-60:												
Natural increase 1/	2,287		4,127		954		3,380		2,075		12,823	
Net migration 2/	-3,565	-27.1	2,461	+12.6	161	+3.1	-1,688	-11.1	-444	-6.1	-3,075	-5.1
Population change	-1,278		6,588		1,115		1,692		1,631		9,748	
1960 population	11,898		26,168		6,365		16,874		8,883		70,188	
1960-70:												
Natural increase 1/	1,010		4,283		169		2,092		1,129		8,683	
Net migration 2/	-2,706	-22.7	-2,099	- 8.0	-1,582	-24.9	-1,634	- 9.4	-2,443	-27.5	-10,464	-14.8
Population change	-1,696		2,184		-1,413		458		-1,314		- 1,781	
1970 population	10,202		28,352		4,952		17,332		7,569		68,407	

1/ Births to resident mothers minus deaths of residents.

2/ Population change minus natural increase.

Figure III-1--Population distribution in percentages by age group and race, 1960 and 1970--
Wind-Bighorn-Clarks Fork Basin in Wyoming



for the non-Indian population. The difference in age composition between whites and nonwhites (primarily Indians) is shown in table III-5.

Educational achievements for the rural farm and nonwhite population are below comparable figures for the population as a whole. In 1960 the median number of school years completed for persons 25 years old and over were 11.7, 11.2, and 8.7 years respectively for all residents, rural-farm residents, and nonwhite residents. By 1970 comparable educational levels had increased to 12.3, 12.1, and 11.1 years, respectively.

Table III-5--Percent distribution of population by age groups and by race in 1970

Age group	Whites 1960	Whites 1970	Nonwhite 1960	Nonwhite 1970
	percent			
75+	2.7	3.7	1.4	1.6
65-74	5.2	5.7	3.0	3.2
55-64	7.6	9.8	5.0	4.6
45-54	11.4	11.6	5.9	7.5
35-44	12.8	11.5	9.3	9.7
25-34	12.8	11.7	12.2	12.0
15-24	13.1	15.6	15.2	19.0
5-14	22.0	22.1	29.2	29.3
Under 5	12.4	8.3	18.8	13.1
Total	100.0	100.0	100.0	100.0

Source: U.S. Census of Population

Labor force and employment

All persons at 16 years of age are considered to be eligible for participation in the labor force. In addition to employed persons, the labor force includes those unemployed but seeking employment. The percentage of eligible persons who participate in the labor force varies from county to county (table III-6). Part of this variation is due to the availability of continuous employment opportunities, willingness to continue education, and desire to work. The participation rate also varies among age groups. A major portion of the labor force is in the 25-64 age group. This age group is becoming a larger part of the total because there is a tendency for young workers to delay their entry into the labor force because of educational opportunities and training requirements. Also, improved retirement benefits have attracted older workers to consider earlier retirement.

Table III-6--Labor force participation rates and unemployment rates, Wyoming study area, 1970

	Big Horn	Fremont	Hot Springs	Park	Washakie	5 county area
	number					
Persons 16 years of age and over	7,001	18,170	3,494	11,940	4,989	45,594
Persons in labor force	3,921	10,748	1,852	7,109	3,080	26,710
	percent					
Participation rate:						
Male:	76.6	76.7	67.7	80.9	82.6	77.8
Female:	35.9	41.6	39.5	39.4	40.5	39.9
Unemployment rate						
Male:	2.9	7.0	4.0	3.1	4.5	4.8
Female:	6.6	6.1	4.6	7.0	4.9	6.2

Source: 1970 Census of Population

A certain amount of unemployment is inevitable wherever individuals can change jobs. This is a transitional unemployment which is of limited duration. The 5.0 percent unemployment rate of the Wind-Bighorn-Clarks Fork area appears to be little, if any, above the national norm. In addition to the unemployed, there are many persons whose labor is underutilized and whose incomes are below what they might be.

Underemployment differs from unemployment only in that human resources are utilized to some extent. An unemployed person cannot find work, while an underemployed individual can find work but at an amount less than he desires. One cause of underemployment is hidden because some people do not look for jobs. When there is a lack of employment opportunities, they withdraw from the labor force and are not counted as unemployed. Another cause is the immobility of people, especially those above 45 years of age. They are reluctant to leave familiar surroundings even if employment opportunities appear elsewhere. The natural surroundings of the basin area also add to this situation. Fishing and hunting may not be readily sacrificed for added income. Many jobs are seasonal, leaving people unemployed or underemployed at least part of the year. Farming, food processing industries, mining, and recreation may provide only seasonal employment. Employment at the sugar refineries is at a peak for a period following harvest. The tourist trade is limited to the summer months, thus affecting many employees.

One technique for measuring underemployment is to determine whether incomes are below capacity. Income capacities are determined by comparing

selected attributes of the male and female labor force in this study area to like attributes for the nation as a whole. Reported median incomes for the labor force in the study area were then compared with an imputed median income reflecting the earning capacity of segments of the national labor force with similar earnings characteristics. The ratio between these indicators measures the degree of underemployment. In 1960 underemployment rates were 12 percent of the male labor force and 43 percent of the female labor force, for a combined 20 percent of the total labor force. Severe underemployment exists at 20 percent or over. Underemployment as well as unemployment rates are even higher on the Wind River Indian Reservation.

The increase in population from 1940 to 1960 was closely related to the growth in nonfarm employment opportunities. Total employment increased 55 percent during the period despite a continued decrease in agricultural employment as shown in table III-7. Employees of agriculturally related firms are not included with agricultural employment, but appear in manufacturing, distributive, and service categories.

Basic industries of the area include agriculture, forestry, mining, and manufacturing. In 1940 they provided 55 percent of all jobs, but by 1970 this percentage dropped to 33. The sizeable increase in mining activities prevented a further decline. Agriculture was the only major industry in which employment declined for the entire 30-year period. There was a sharp increase in employment in the construction, transportation, communications, utility, trade, financial, realty, and service sectors during the 1940's. During the next decade employment continued to grow in most of these sectors, but at a lower rate. Construction was the lone exception, where employment decreased nearly one-third. Employment in this sector continued to decline during the 60's. Agriculture, forestry, transportation, communications, and utilities also had fewer workers by 1970. Although population declined by 1,781, total employment increased by 499.

It should be noted that most, if not all, of the overall growth in employment from 1950 to 1970 reflected an increase in jobs held by women. Female labor force participation rates have been increasing in the study area. One reason for increased participation is farm women generally have not been counted as a part of the labor force, even though they may contribute significantly to agricultural output. However, as farm women seek off-farm employment or as they migrate off farms and obtain jobs, they are counted in the labor force and in total employment. Another reason is the tendency for women who have finished rearing their family to find jobs in service-type industries. More of these jobs are becoming available, and they can often be filled by workers with little specialized training.

Economic activity in the business and manufacturing sectors is shown in table III-8. Trends in the number of establishments vary by industry, but the monetary measurement of business activity is upward for all sectors.

Table III-7—Employment by industry, Wyoming

Industry	1940	1950	1960	1970	Change 40-50	Change 50-60	Change 60-70	Distribution 1960	Distribution 1970
	number				percent			percent	
Agriculture and forestry	7,413	6,585	4,816	3,521	-11.2	-26.9	-26.9	19.4	13.9
Mining	487	1,455	2,870	2,987	+198.8	+97.3	+ 4.1	11.6	11.8
Construction	1,017	2,880	2,015	1,785	+183.2	-30.0	-11.4	8.1	7.1
Manufacturing	865	1,127	1,425	1,908	+ 30.3	+26.4	+33.9	5.8	7.5
Food Prod.	(249)	(281)	(380)	(335)	+ 12.9	+35.2	-11.8		
Lumber Prod.	(168)	(119)	(125)	(199)	-29.2	+ 5.0	+59.2		
Other mfg.	(448)	(727)	(920)	(1,374)	+62.3	+26.5	+49.3		
Transportation, comm. & utilities	644	1,493	1,742	1,528	+131.8	+16.7	-12.3	7.0	6.0
Wholesale trade	255	462	451	674	+81.2	- 2.4	+49.4	1.8	2.7
Retail trade	1,771	2,827	4,110	4,318	+59.6	+45.4	+ 5.1	16.6	17.1
Finance, Insurance, and real estate	174	506	530	622	+190.8	+ 4.7	+17.4	2.1	2.5
Services	2,476	3,453	5,278	6,454	+39.5	+52.9	+22.3	21.3	25.5
Government	551	878	1,015	1,492	+59.3	+15.6	+47.0	4.1	5.9
Not reported	300	335	538	NA	+11.7	+60.6	NA	2.2	NA
Area total	15,953	22,001	24,790	25,289	+37.9	+12.7	+ 2.0	100.0	100.0
Male	13,738	17,613	17,966	16,650	+28.2	+ 2.0	-7.3	72.5	65.8
Female	2,215	4,388	6,824	8,639	+98.1	+55.5	+26.6	27.5	34.2
Wyoming	86,559	114,715	123,309	123,389	+32.5	+ 7.5	+ 0.1	Not applicable	

Source: U.S. Census of Population

Table III-8--Number of business establishments and reported economic activity, 1958-1967

Sector	Unit	1958	1963	1967
Wholesale trade:				
Establishments	No.	138	128	128
Sales	$ million	33.6	32.3	44.8
Retail trade:				
Establishments	No.	838	875	906
Sales	$ million	85.0	98.6	101.1
Selected services:				
Establishments	No.	587	677	660
Receipts	$ million	9.1	14.8	18.5
Mineral industries:				
Establishments	No.	292	304	217
Value of shipments and receipts	$ million	239.1	276.7	264.9
Manufacturing:				
Establishments	No.	75	90 1/	83 1/
Value added	$ million	9.4	16.0	14.9

Source: Census of Business
Census of Manufacturing

1/ Data for Hot Springs County withheld to avoid disclosure of individual firms and not included in totals shown.

In 1967, 61.7 million barrels of crude oil, 546 thousand tons of processed bentonite, 2 thousand tons of uranium (U_3O_8) and 1.5 million tons of usable iron ore were produced in the five county area.

Income

Another measure of economic well-being in an area is personal income. Total personal income for the study area increased from 24 million dollars in 1940 to 225 million in 1970 (table III-9). This is an increase of 842 percent as compared to 775 percent for the nation. Per capita income increased during the same periods. However, in 1970 it was 16 percent below the national average.

Personal income normally increases over time for two reasons. The first is increasing production, which implies rising income. The second source is price inflation. It is important to distinguish between the two influences, because the latter can exaggerate the growth of income during

Table III-9--Personal income and earnings by broad industrial sector, for selected years

Category	1940	1950	1959	1966	1968	1970
	(thousands of dollars) 2/					
Total personal income	23,921	81,965	129,580	170,225	195,537	225,342
Per capita income 1/	476	1,359	1,904	2,538	2,916	3,294
Per capita income comparison to U.S. - 100	80	91	88	86	85	84
Total earnings	20,495	67,012	107,329	136,059	155,931	176,422
Farm earnings	7,997	16,827	17,604	16,185	18,476	15,429
Total nonfarm earnings	12,498	50,185	89,725	119,874	137,455	160,993
Government earnings	3,164	8,837	15,439	24,795	29,256	34,915
Private nonfarm earnings	9,334	41,348	74,286	95,079	108,199	126,078
Manufacturing	1,272	4,409	5,237	11,112	13,621	15,703
Mining	653	4,215	16,930	20,545	25,441	29,333
Contract Construction	959	7,298	10,354	12,413	13,271	15,721
Transportation, Communications, and Public Utilities	991	3,932	7,429	8,603	9,638	10,901
Wholesale and Retail Trade	3,719	14,179	20,005	19,962	21,095	24,107
Finance, Insurance, and Real Estate	262	1,655	2,438	3,613	4,021	4,372
Services	1,444	5,589	11,488	17,990	20,248	24,901
Other	34	71	405	841	864	1,040
	(thousands of dollars) 3/					
Total personal income	60,103	113,055	146,418	174,590	188,742	199,428
Per capita income	1,191	1,874	2,151	2,603	2,814	2,915

Source: Office of Business Economics Information System
1/ Per capita income is shown in dollars
2/ Current dollars
3/ 1967 constant dollars

a period of inflation. Inflation is reflected in rising prices of goods and services, as well as in increased money income to individuals, businesses, and government. The implicit price deflator for personal consumption expenditures at the national level was used to eliminate the influence of price inflation. Total personal income after adjustment to a 1967 dollar base is also shown in table III-9.

Income per family in the study area is lower than that for Wyoming as a whole. About 10.6 percent of all families had incomes below the poverty level as compared to 9.3 percent in this category for Wyoming. Similar statistics for rural farm families in the study area and the state are 13.7 percent and 12.1 percent respectively. Fremont County with 21 percent showed the highest incidence of below poverty level income for rural farm families in the state. This situation is largely influenced by the rural Indian population on the Wind River Reservation.

Wage and salary disbursements, other labor income, and proprietor's income elements of personal income are combined and referred to as earnings. Earnings account for about 80 percent of total personal income in the study area. Total earnings are shown by major sectors of the economy. In 1940 farm earnings were 39 percent of total earnings but declined to 9 percent by 1970. Meanwhile, earnings from mining rose from 3 percent to 17 percent of the total.

Projections

Total employment in the study area is projected to increase by the year 2020. All of the increase will occur in nonagricultural sectors as agricultural employment will continue to decline. Agricultural employment is projected to be 2,900 in 1980; 2,400 in 2000; and 2,200 in 2020. This is a 40 percent decrease from 1970 to 2020.

Total population is projected to be 119,700 by 2020. This is an increase of about 75 percent from the 1970 population. Population projections are based upon employment projections and estimated employment participation rates. By 2020 it is estimated that the population of the nation will more than double. Estimates of population, employment, and per capita income changes for the projection period are shown in table III-10.

AGRICULTURE AND RELATED ACTIVITY

General

Agriculture is an important segment of the basin's economy. Its importance has been evident historically and can be expected to continue. Despite a decline in the number of farms and farm operators, agriculture is an expanding industry in the area. The inverse relationship between increasing agricultural production and declining farm population stems largely from an increase in farm efficiency through the use of conservation programs, improved technology, feed additives, fertilizers, insecticides,

Table III-10--Projected population, employment, and per capita income

Item	1970	1980	2000	2020
Population:	68,407	76,600	96,700	119,700
Rural farm	10,612	9,000	7,600	7,000
Employment:	25,289	29,100	37,700	47,900
Agricultural	3,521	2,900	2,400	2,200
Other basic	4,895	5,400	5,700	5,600
Non-basic	16,873	20,800	29,600	40,100
Per capita income 1/	2,915	4,000	7,300	12,900
National average per capita income	3,470	4,765	8,289	14,260

1/ 1967 dollars
Source: Office of Business Economics data and census data adjusted to local conditions.

and larger farm machinery. Further increases in efficiencies are expected through year 2020. Total consumption of agricultural products will expand as population of the study area and the nation increases. Rising per capita income leads to additional expenditures for some food items. As incomes grow, consumers tend to upgrade their diets; and this generally means eating more meat, especially beef. Cattle operations are the most important agricultural endeavor in this area. Most of the beef produced is sold in the form of feeder cattle and calves to out-of-state feedlots. The basin has sufficient resources to increase both crop and livestock output above present levels of production.

According to the Census of Agriculture, the amount of land in farms and ranches is about 5.3 million acres. Livestock producers in the study area also obtain grazing leases and permits on adjacent public lands, and this increases the total amount of land used for agricultural production. Although the total amount of land used for agricultural purposes has remained relatively constant, many other farm characteristics for the study area have been altered during the past two decades as shown in table III-11. The direction of these changes is similar for the nation and the State of Wyoming. Out-migration of the population, particularly the rural population, has been instrumental in the decline of farm numbers. The remaining farms are larger, produce more, and have a greater capital investment. Average farm size has a limited meaning in the study area because farm and ranch units vary from those specializing in intensively irrigated row crops to those with extensive livestock operations. In 1969, 22 percent of all units were less than 100 acres in size, while 19 percent were 1,000 acres or larger.

Table III-11--Characteristics of farms

Item	Unit	1954	1959	1964	1969
Farms	No.	3,501	2,953	2,650	2,275
Average farm size	Ac.	1,490	1,843	2,243	2,341
Ownership class:					
Full owner	Pct.	54	48	48	51
Part owner	Pct.	27	33	36	36
Tenants	Pct.	19	19	16	13
Size class:					
Under 100 acres	Pct.	25	20	20	22
100-179 acres	Pct.	25	19	15	13
180-259 acres	Pct.	12	13	11	11
260-499 acres	Pct.	18	22	24	21
500-999 acres	Pct.	8	10	12	14
Over 1,000 acres	Pct.	12	16	18	19
Value of land and buildings:					
Per farm	Dol.	26,492	42,977	74,568	112,275
Per acre	Dol.	20	35	33	48

Source: U.S. Census of Agriculture

The per acre value of land and buildings increased 2½ times between 1954 and 1969. This is partially due to higher land prices and building construction costs, and partially due to other capital investments such as irrigation equipment and drainage systems. The combination of higher price per acre and increased farm size has resulted in an average investment of greater than $100,000 per farm. Large capital requirements are also reflected in farm ownership. The percentage of farmers and ranchers who own only a part of the land they operate rose from 27 percent in 1954 to 36 percent in 1969. Meanwhile, those in full ownership and tenant categories declined. Apparently, farm operators are satisfied to have less than full control of the land resource so they can obtain capital for current operations. Little change can be expected in this trend as farm size, land values, and machinery costs continue to increase.

Agriculture also provides many of the primary inputs to other sectors of the economy. Sugar beet refineries, food processing plants, marketing, and transportation industries are heavily dependent upon the crops and livestock produced locally. The amount of processing performed varies by type of product and can range from a small amount as in the case of feed grains to providing a finished product such as sugar. Farmers and their families are an important source of labor. They can supplement farm income with seasonal, part-time, and in some cases, with full-time jobs.

In 1969, 696 farm operators that sold at least $2,500 of farm products also worked at jobs away from their farm. Over one-half of these operators held a job 100 or more days per year.

Land use and production

There are about 5.1 million acres of agricultural land in the basin that were inventoried during 1967 to determine use and conservation treatment needs.1/ Most of this privately-owned land is utilized for roughages, grazing, and feed grains in support of the livestock industry. Land uses include irrigated pasture and cropland, nonirrigated cropland, range, forest, and other agricultural uses. Little additional land will be needed for transportation, urban, and built-up areas in future time periods. Consequently, the amount of agricultural land is expected to remain at the present acreage.

Recent trends in areas harvested for selected crops are shown in table III-12. The acreage of oats, wheat, and beans has declined substantially since 1950. The latter began to subside during the early 1960's and then fell off sharply as farmers began growing malting barley.

Table III-12--Trends in cropland acres for selected years in five county area

Crop	1950	1960	1964	1968	1970
Corn for grain	340	1,350	2,490	2,500	5,000
Corn silage	2,795	9,570	11,200	14,800	15,700
Sugar beets	15,634	21,457	42,397	43,985	41,642
Oats	45,400	31,000	28,600	27,800	29,300
Barley	39,000	30,500	33,200	39,600	52,700
Wheat	14,300	6,190	2,490	2,900	2,350
Dry beans	44,300	43,850	28,370	20,500	13,600
Alfalfa hay	110,900	155,500	159,400	145,500	148,000

Source: Wyoming Cooperative Crop and Livestock Reporting Service, Cheyenne, Wyoming.

1/ Conservation Needs Inventory, Wyoming 1967

Malting barley is a relatively new crop to the basin, but a potential exists for increasing production because the altitude and climate lend to growing a desirable product. It is estimated that nearly 30 percent of all barley produced in 1968 was malting barley. Total barley acreage has increased, but the amount used to grow barley for feed has decreased slightly. Barley, oats, and corn are used primarily as feed by the producers and marketed as livestock or livestock products. The irrigated acres of corn harvested for grain more than doubled between 1960 and 1970. Most of the increase can be attributed to the use of early maturing corn varieties. Total feed grain production in the basin is greater now than before because per acre yields have more than offset any decline in acreage.

Sugar beets is the principal cash crop grown in the basin. Although the amount grown has increased, federal programs have more influence on this crop than any other. Most of the increase occurred following an embargo on Cuban sugar. Nevertheless, sugar imports account for over 40 percent of the total sugar consumed nationally at the present time.

Corn silage is produced on more acres each year. The increase in popularity of this crop is due to development of more favorable varieties that result in high production. Improved methods of storage have also enhanced production. The acres of dry beans in 1970 were about one-fourth the acreage in 1950. Some of the decline is due to changed consumer preferences. Also, competing areas have attracted dry bean production away from the basin. Further, alternative crops that are more profitable are now produced. The acres of hay crops have not changed appreciably during the past decade. Some of the mountain meadows are cut for hay as well as used for grazing.

There are about 539,000 acres now irrigated (including idle land with an irrigation water supply) in the basin. About 117,000 acres are used for pasture, 255,900 acres for harvested roughages and hay, and 70,000 acres for feed grains. There are over 29,000 acres of irrigated cropland with very low production. These acres are scattered among the productive lands and use water inefficiently when it is available. They have water rights and usually are so intermingled with productive lands that they are maintained as irrigated land.

Sugar beets and dry beans are the predominant cash crops on irrigated land, although smaller acreages of wheat, vegetables, 1/ and other crops are also harvested. Climatic conditions, primarily insufficient rainfall, limit the amount of nonirrigated cropland to 4,000 acres. Wheat and barley are the dryland crops harvested. Present and projected land uses on state and private lands are shown in table III-13.

The amount of irrigated land is expected to increase from the present 538,830 acres to 555,300 in 1980; to 571,300 in 2000; and 600,100 in 2020. The additional irrigated land will be used primarily for barley, sugar beets, hay, and pasture. Corn for grain and corn silage acreages will also increase. Livestock production will continue to be of major importance; and additional roughage, grazing, and feed grains will be

1/ Mostly potatoes.

Table III-13--Present and projected land use on state and private lands

Crop	Present 1/	1980	2000 2/	2020 2/
	acres			
Irrigated:	538,830	555,300	571,300	600,100
Wheat	2,500	2,200	1,800	1,500
Barley	42,200	53,000	60,000	63,000
Oats	27,000	22,000	19,700	18,100
Corn Grain	3,100	4,000	5,000	6,100
Sugar beets	41,200	36,000	49,300	61,100
Dry beans	16,700	11,000	11,000	11,000
Vegetables 3/	1,500	1,000	1,200	1,300
Other crops	2,500	2,500	2,500	2,500
Silage	15,000	16,800	18,000	18,000
Alfalfa hay	151,900	159,000	157,500	162,100
Improved grass hay	79,000	79,000	79,000	79,000
Native hay	10,000	10,000	10,000	10,000
Rotation pasture	9,000	9,000	9,000	9,000
Permanent pasture	108,000	120,600	118,100	128,200
Not harvested	29,230	29,200	29,200	29,200
Non-irrigated:	4,070	2,500	2,500	2,000
Barley	1,200	1,000	1,000	1,000
Wheat	1,470	1,000	1,000	1,000
Fallow	1,400	500	500	--
Range	4,170,050	4,155,150	4,139,150	4,110,850
Forest	340,300	340,300	340,300	340,300
Other 2/	61,960	61,960	61,960	61,960
Total 2/	5,115,210	5,115,210	5,115,210	5,115,210

1/ Present cropland use generally represents a 1965-70 weighted average.

2/ Does not include 144,850 acres of water and state and private lands in non-agricultural uses.

3/ Mostly potatoes.

needed. The amount of nonirrigated cropland is quite small and is expected to decrease further. The estimated reduction in rangeland acres is a result of converting nonirrigated range to irrigated cropland. Lands suitable for irrigation on public lands may be available for future irrigation development. However, this was not considered in the projections.

Productivity per acre has been increasing in the past and can be expected to expand further through 2020. Present and projected crop yields

are shown in table III-14. The additional capacity to produce will come about partly through use of improved crop varieties and management, improved fertilizer and weed control applications, and application of measures to conserve soil and water resources. Irrigated and nonirrigated barley yields are expected to increase about 80 percent by 2020. Improved grass hay yields probably will more than double during the same period. Alfalfa hay and sugar beets yields are estimated to increase 54 percent and 73 percent, respectively.

Present and projected production for the major commodities are shown in table III-15. For most crops, present production is a weighted average for the years 1965-70. The estimate of grazing on public lands was obtained through the federal agencies issuing grazing leases and licenses. Currently, public lands provide 33 percent of the grazing resource. Production of livestock commodities was determined by relating inventories and sales for the basin to the state total and converting to units of weight.

Projected production levels for the basin are based upon the national rate of increase (or decrease) for each commodity and time period. These rates were altered upward or downward for some items based upon historical comparisons of significant trend changes between the areas. Upward adjustments were allowed for corn for grain, sugar beets, barley, and oats. Downward adjustments were made for dry beans, wheat, and some of the livestock commodities. Only a minor adjustment was permitted for cattle and calves. National projections are influenced by population growth, income, consumer tastes and preferences, per capita consumption, exports and imports, as well as industrial uses of agricultural products.

Most of the agricultural commodities produced in the basin, except for feed grains and roughages, are marketed for consumption, processing, or fattening in areas outside the state. The livestock operations in the basin are largely cow-calf and ewe-lamb enterprises that provide feeders to feed-lots. Projections of hay and grazing are based on the amount of each needed to supply adequate roughage.

The amount of roughage from grazing public and private ranges was added to the amount produced on irrigated land and from nonirrigated hay. It was assumed that any additional roughage would come from new hay, pasture, and silage crops. Therefore, the estimated increase in irrigated acres is reflected in these roughage crops. One exception is the use of beet tops. It is assumed that all sugar beet tops will be fed as silage or grazed.

Currently, the amount of grain fed is in excess of production. Although production is projected to increase 41 percent by 1980, 85 percent by 2000, and 126 percent by 2020, a deficit of feed grains will continue. Sugar beet production is projected to increase slightly by 1980 and then more than double by 2020. Production of dry beans will decrease by 1980 and then increase to the present level by 2000.

Beef production is projected to increase 35 percent by 1980 and 135 percent by 2020. Sheep and lamb production is projected to decline by 1980

Table III-14--Present and projected crop yields

Crop	Unit	Present yield per acre	Projected yields per acre 1980	2000	2020	Index (Present = 100) 1980	2000	2020
Irrigated crops:								
Wheat	Bu.	38	42	54	66	111	142	174
Barley	Bu.	63	80	96	113	127	152	179
Oats	Bu.	54	69	85	101	128	157	187
Corn, grain	Bu.	69	85	96	108	123	139	157
Sugar beets	Ton	17.0	19.9	24.5	29.4	117	144	173
Dry beans	Cwt	16.4	20.1	25.2	30.0	123	154	183
Vegetables 2/	Cwt	195	300	350	400	154	179	205
Corn silage	Ton	15.0	18.0	23.2	27.1	120	155	181
Alfalfa hay	Ton	2.8	3.2	3.7	4.3	114	132	154
Improved grass hay	Ton	1.3	1.8	2.3	2.8	138	177	215
Native hay	Ton	1.1	1.3	1.6	2.0	118	145	182
Permanent pasture	FU 1/	1,680	1,980	2,240	2,470	117	133	147
Rotation pasture	FU 1/	2,330	2,690	2,970	3,220	115	127	138
Non-irrigated crops:								
Barley	Bu.	27	34	42	50	126	156	185
Wheat	Bu.	24	30	39	48	125	162	200
Range	FU 1/	123	157	183	198	127	148	161

1/ Feed unit: One feed unit is equivalent to one pound of shelled corn.

2/ Mostly potatoes.

Table III-15--Current and projected production and values of productions

Crop	Unit	Price per unit	Current	1980	2000	2020
Wheat	Bu.	1.73	128,430	122,400	135,900	147,000
Barley	Bu.	.96	2,693,170	4,274,000	5,802,000	7,169,000
Oats	Bu.	.65	1,461,460	1,518,000	1,675,000	1,828,000
Corn, grain	Bu.	1.16	214,310	340,000	480,000	658,800
Sugar beets	Ton	12.17	700,160	716,400	1,207,900	1,796,300
Dry beans	Cwt.	6.27	273,520	221,100	277,200	330,000
Vegetables 6/	Cwt.	1.38	292,500	300,000	420,000	520,000
Silage	Ton	8.00	225,000	302,400	417,600	487,800
Alfalfa hay	Ton	22.00	425,340	508,800	582,600	697,000
Other hay	Ton	22.00	113,700	155,200	197,700	241,200
Pasture	AUM	6.75	449,800	584,573	647,127	768,076
Range	AUM	6.75	1,081,100	1,379,938	1,608,464	1,740,307
Range 5/ (Public land)	AUM	6.75	762,936	768,616	784,849	784,849
Beef	Lb. 2/ 4/	23.47 7/	106,800	144,420	195,600	251,311
Pork	Lb. 2/ 4/	15.50 7/	4,500	4,700	4,900	5,000
Sheep	Lb. 2/ 4/	13.85 7/	15,800	13,400	16,100	18,600
Wool	Lb. 2/	47.00 7/	3,002	2,546	3,059	3,534
Milk	Lb. 2/	.398 7/	40,000	34,000	38,000	42,000
Eggs	Doz. 2/	.39	1,207	990	1,030	1,070
Poultry	Lb. 2/ 4/	5.00 1/	222	182	190	198
Aggregate value of production	Dol. 1/ 2/		75,225	91,115	117,757	146,602
Value of feed utilized	Dol. 1/ 2/		32,151	39,729	46,575	53,542
Gross value of production	Dol. 1/ 2/		43,074	51,386	71,182	93,060

1/ Current Normalized Price, Interim Price Standards for Planning and Evaluating Water and Land Resources, Water Resources Council, April 1966.

2/ Units in thousands.

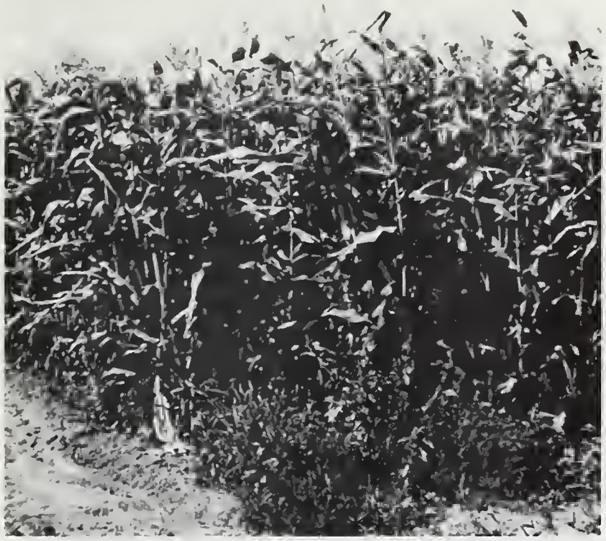
3/ One animal unit month (AUM) = 450 feed units.

4/ Live weight basis.

5/ Grazing obtained through leases and licenses administered by federal agencies.

6/ Mostly potatoes.

7/ Prices of livestock products except eggs are for cwt.



Corn for silage and grain is increasing in importance in the basin

Good yields of alfalfa are possible with full water supplies, good drainage, fertilizer, and good irrigation management.

Sprinkler systems are bringing land under irrigation that is too rough or has soils unsuited for irrigation under conventional systems.

PLATE 12

About 6,000,000 cubic feet of industrial wood products came from the basin in 1962.

U.S. FOREST SERVICE PHOTO

By 1980 the demand for the basin's timber products is expected to exceed the supply by 3,000,000 cubic feet per year.

PLATE 13

and then increase to 18 percent above present output by 2020. Projection of output for pork, wool, milk, eggs, and poultry indicate relatively minor changes from present levels.

There are numerous considerations inherent in making projections for any area. The foregoing projections are based upon national trends and adjusted for local conditions. The demand for goods and services produced from the water and land resources of the basin is influenced by market conditions in other areas. A large part of the agricultural output is exported from the basin. The agricultural commodities produced are not unique to this basin. They are also produced in competing areas throughout the nation and the world. Local producers have little command over the prices they pay or receive. If future cropland yields are underestimated, then less than the projected area of new irrigated cropland will be required to provide the same level of output.

The heavy reliance on nonlocal markets and the competitive nature of local goods and services imposes important economic restrictions on local production. If an excess is produced and marketed, there will be either a decline in prices or an accumulation of surpluses. Large production increases may affect market prices to the extent that net returns to agriculture are reduced.

However, a change in demand for agricultural commodities at the national level will have a similar effect at the local level. Recently there has been a significant increase in international trade. If the increased demand for agricultural products from the U.S. continues, there will likely be a production increase in this basin.

There is the possibility that technology will not be available to increase crop yields to the extent shown in the projections. If crop yields for the irrigated lands are overestimated by 10 percent, an additional 55,000 acres of irrigated land would be needed by 1980 to provide the same amount of output. By year 2020, 60,000 acres more than the presently projected amount would be needed.

The importance of public lands as a source of grazing was indicated earlier. It is assumed that most of the public land will continue to be available to livestock producers. However, if this resource becomes no longer available for grazing there must be an increase in production from private lands. It would require about 175,000 acres of irrigated pasture to replace the amount of grazing that is expected to be produced on public lands in 1980. By 2020 it would take about 143,000 acres of irrigated pasture to replace grazing on the public land.

FOREST RESOURCES AND RELATED ECONOMICS

Timber - supply and demand

In 1970 the Forest Service and other agencies cooperated with the Office of Business Economics and the Economic Research Service to produce

a national assessment of water and related land resources. One result is a projection of national timber supplies and demands to the year 2020 with intermediate projections for 1980 and 2000. The national projections were allocated to major water regions and to subbasins. Use of the projections enables planners to identify the share of national demands which the subbasin is expected to provide and to compare prospective supplies to the demands. In 1962, the base year of the assessment, the Wind-Bighorn-Clarks Fork River Basin1/ produced about 6 million cubic feet of industrial wood products. The estimated volume of growing stock2/ available for harvest that year was 12 million cubic feet. By 1980 the demand for timber products from this basin is expected to exceed the supply by 3 million cubic feet or nearly 12 percent. The demand will continue to outstrip the supply by an increasing margin in the future if current levels of management, market prices, and other conditions remain constant or maintain current trends in change (table III-16).

Utilization - volume and value of output

The basin's average annual timber harvest for the 1962-71 period was 29,500,000 board feet or 6,200,000 cubic feet. Table III-17 lists the general locations of this harvest. About 75 percent was harvested from national forests. The remainder comes from state-owned forest land, private lands, the Wind River Indian Reservation, and land administered by the Bureau of Land Management.

About 96.3 percent of the total timber harvest was manufactured into lumber. The remainder was used for railroad ties, mine timbers, house logs, lath, posts, poles, and fuel.

The stumpage value of the 28,410,000 board feet of timber manufactured into lumber was about $146,330 at 1969-72 average prices. Harvesting and transporting timber added to the value of these products. The value added was obtained by deducting the costs of stumpage and of intermediate products (such as fuel and harvesting equipment) from the total value of timber at local points of delivery.

An estimated $475,570 annually was added to the value of timber by harvesting activities. It was assumed that all of this value added could be attributed to the timber industry. Similarly, the value of shipments from primary manufacturing plant reflected the value of manufactured forest products. The value added by primary manufacturing was obtained by deducting the costs of stumpage, logs, fuels, chemicals,

---

1/ The boundaries of the subbasin used in the assessment are not exactly identical with the boundaries defined in this report. However, the area of commercial forest land is approximately the same.

2/ Growing stock volume consists of all live trees except live culls, 5.0 inches d.b.h. and larger. (Rough and rotten trees which are alive are not included. Sawtimber is included as a component of growing stock.)

Table III-16--Projected annual volume of growing stock 1/ available and demand for roundwood 2/ in 1980, 2000, and 2020, Wind-Bighorn-Clarks Fork River Basin in Montana and Wyoming 3/

Year	Supply of growing stock available	Projected demand of domestic roundwood
	million cubic feet	
1980	23	26
2000	31	45
2020	31	51

1/ Net volume of growing stock trees removed from inventory by harvesting, cultural operations, land clearing, or changes in land use.

2/ Logs, bolts, or other roundwood sections cut from trees for industrial or consumer uses.

3/ Nearly all of this is in Wyoming.

Source:
U.S. Forest Service and OBERS data prepared for the National Assessment of Water and Related Land Resources, July 1970 and revisions of June 1971.

Table III-17--Average annual timber cut by ownership and product class, 1962-1971

Ownership	Average annual cut: Growing stock	Roundwood	Sawtimber
	thousand cubic feet	thousand cubic feet	thousand board feet
National forest	4,600	200	21,500
Public domain	insignificant	--	200
Wind River Indian Reservation	1,100	--	5,100
State and private	500	--	2,500
Total	6,200	200	29,300

and other intermediate products purchased from other sectors of the economy from the total value of shipments. The average annual value added by manufacturing was estimated to be $548,710. A portion of the value added (3.5 percent) could be attributed to other sectors of the economy. Thus, the value added, which was attributable to timber, was about $529,500 annually. The total value of timber in the basin's economy was the sum of stumpage and value added by harvesting and primary manufacturing. This was estimated to be $1,170,600 annually.1/

Employment and income

In 1960 logging and forest products manufacturing firms employed 125 persons. In 1971 nine firms had employed a sum of about 180 production employees and 40 clerical and managerial employees. Because the projected annual cut of timber in the basin (see table III-18) is not significantly different from that of the past, employment should decrease as labor-saving technology is introduced.

Table III-18--Projected annual cut of timber in the basin

Source	Amount
	--thousand board feet/ year--------
National forest land a/	
Bighorn National Forest	16,000
Shoshone National Forest	6,000
Bureau of Land Management land b/	200
Land in Wind River Indian Reservation b/	200
State and private forest land c/	2,500
TOTAL	25,900

a/ Information provided by national forests.

b/ Information provided by Soil Conservation Service.

c/ 361,000 acres of state and private forest land. Assume 70 percent of this is commercial (based on total basin acreage ratios). Then 252,700 acres are assumed to have an average annual cut of 10 board feet per acre per year.

1/ The estimates of value added were based on ratios derived from data presented in USDA Mscellaneous Publication 941, The Economic Importance of Timber in the United States.

Recreation on forest lands

The forest lands in the basin have a large supply of high quality recreation resources. The major recreation activities are sight-seeing, camping, resort use, hunting, and fishing. The influx of recreationists has an important impact on the local economy. A California recreation study [1/] estimated that campers, day-users, motel and lodge guests, and mountain home occupants averaged per capita daily expenditures of $1.48, $1.62, $8.95, and $1.76 respectively. Sales to visitors do not represent the entire impact of their spending on the local economy. The total impact must include income and employment effects on the local economy.

Recreation use is expected to increase substantially by 2000 and 2020 because of national population growth and increased participation rates. About 80 percent of the total use is expected to occur on weekends and holidays. Striving to meet these peak demands may not always be economically attractive. Patterns and types of recreation uses are changing rapidly.

RELATIONSHIP OF ECONOMIC DEVELOPMENT AND WATER RESOURCES DEVELOPMENT

Land and water resource developments for use in agricultural production were virtually unknown in the basin until the 1880's and 90's. The first were irrigation works built by individual farmers followed by developments made possible through the Carey Act. During this time, some of the land was denuded of its virgin cover and planted to vegetation that had water requirements greater than the amount available through the normal supply of rainfall. Sugar beets, dry beans, alfalfa hay, and feed grains were no longer alien to this arid basin.

Crop production from irrigated lands became a progressively larger share of total agricultural production as more areas were irrigated. Currently, over two-thirds of the value of the basin's agricultural output can be attributed to the 538,800 acres receiving full or supplemental supplies of irrigated water. Both private and public investments have been put to use during the era of irrigation development. Private developments contain about 331,200 acres or 61 percent of the total irrigated land; the remaining 207,600 acres are within Reclamation and Bureau of Indian Affairs projects.

National benefits can accrue as a result of future development of water and related land resources. These benefits may be in terms of savings in the cost of producing agricultural products or in terms of improved income. Regional economic benefits are generally more obvious. Additional employment opportunities and increased income may follow water resource development in an area. However, from the national point of view, the amplification of one area's economy may be neutralized by corresponding declines in other areas.

1/ R. Drake, et al. Selected Economic Consequences of Recreation Development: Tuolumne County, Case Study, Agricultural Extension Service, University of California, Berkeley, No. 68-4, June 1968, 66 pp.

RESOURCES FOR RECREATION

Nearly all of the public and most of the private land and water areas in the basin are available for outdoor recreation. Trespass laws and other laws generally require the landowner's permission to use private lands for this or any purpose. User fees are often charged for the use of both private and public property or facilities. Profit and nonprofit indoor recreation facilities are generally available in the basin's larger towns.

The income from recreation activities in the basin is reflected in Table III-9, mainly in the entries for "Services" and "Other." Some of the "Wholesale and retail trade" is also the result of recreation activities. There is no way of knowing for sure, but the income to the basin in Wyoming from outdoor recreation is probably about $8,600,000 per year. Thus, it would rank first among the services and behind government, mining, wholesale and retail trade, construction, manufacturing, agriculture, and utilities and ahead of forestry as an income category.

To avoid unnecessary duplication in this report, most of the discussion about recreation is presented in Chapter V.

Picnicking and camping are among the more important uses of national forest lands in the Basin. USDA - FOREST SERVICE PHOTOS

WYOMING TRAVEL COMMISSION PHOTO

Winter recreation use of national forest lands is rapidly increasing.

SCS PHOTO

PLATE 15

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

The water and related land resources of the Wind-Bighorn-Clarks Fork River Basin are affected by both natural and people-made processes which tend to reduce the quality of or destroy those resources. Other problems are caused by an imbalance of resource availability such as a shortage of irrigation water. This chapter discusses those processes and imbalances, the problems they create, their magnitude, and effect.

EROSION DAMAGE

Erosion damages occur in varying degrees throughout the basin. The two most important types are streambank and gully erosion in the valley alluvium. Approximately 90 percent of the basin's erosion damage occurs in the soft sedimentary rocks on the basin floor and the alluvium in the valley bottoms. Some of this erosion has occurred because modern man has disturbed the vegetation and water flow patterns in the basin.

There is some erosion on forest and rangelands. Erosion is accelerated on these lands by off-road travel by four-wheel drive vehicles, inadequate logging roads and skid trails, fires, overgrazing, and mining. Many miles of inadequately maintained trails are a problem on the Wind River Indian Reservation.

It is estimated that 70,000 acres in the Wyoming portion of the basin have been seriously damaged by erosion in modern times. It is also estimated that about 270 acres are lost annually to gullying and streambank erosion. Over 1,200 miles of streambank are affected each year. Other types of damage also occur to bridge abutments, highways, railroads, canals, fences, and other works of improvement.

The economic and social costs of erosion in the basin are loss of productive land, reduction of crop and forage production; reduction of wildlife, wildlife habitat, recreation, and aesthetics; decrease in farming efficiencies and value of land; and increased cost of operation, maintenance, and construction of transportation and communication facilities.

SEDIMENT YIELD AND DAMAGES

Sediment damages are generally light, but do occur with varying severity throughout the basin. Agricultural lands, stream and river channels, fish and other aquatic life, municipal and irrigation water supplies, capital improvements, reservoirs, and aesthetic values are all damaged by sediment. A sediment yield map is shown in figure IV-1. Sediment yields vary with the geologic parent material in the area. This relationship is shown in table IV-1. For example, 10 percent of the basin is underlain by igneous rock. This area yields 40 percent of the basin's water and .5 percent of the basin's sediment.

Most sediment damages to agricultural lands occur in the irrigated valleys. About 2,500 acres of agricultural land experience some sediment damages annually. Nearly all of the sediment damage on these lands is associated with flooding from nearby streams.

Table IV-1--Relationship of geologic formations to water and sediment yield

Type of parent material	Basin area	Total basin yield	
		Water	Sediment
	------------	percent	------------
Pre-Cambrian igneous	10	40	0.5
Paleozoic and mesozoic sedimentary	35	15	10.0
Tertiary pyroclastics	15	35	12.0
Tertiary sedimentary	25	8	17.5
Quaternary alluvium	15	2	60.0

About 2,000 miles of canals and laterals are damaged by an average of 550,000 tons of sediment annually. At about $.40 per ton to remove it, this amounts to an annual cost of $220,000 to owners in the basin. Sometimes this sediment causes delays in irrigation water deliveries. Sediment carried in canals and ditches is also deposited on fields lowering production and increasing operation costs.

Sediments reduce stream capacities and increase flood hazards. Sediment deposits also promote stream meandering, which causes increased land loss due to bank cutting.

Sediments in the streams can suffocate fish, reduce fish reproduction by covering spawning beds, or starve them by reducing their food supply. Other aquatic life may be similarly affected. This problem is serious enough in the Clarks Fork Subbasin because of high sediment content in the water from the Sand Coulee to attract the attention of fisheries biologists, fishermen, and other citizens and officials.

The rivers in the basin are sources of water for a variety of recreational, domestic, industrial, irrigation, and municipal uses. These

Approximately 80 percent of the basin's erosion damage occurs in gullies and streambanks.

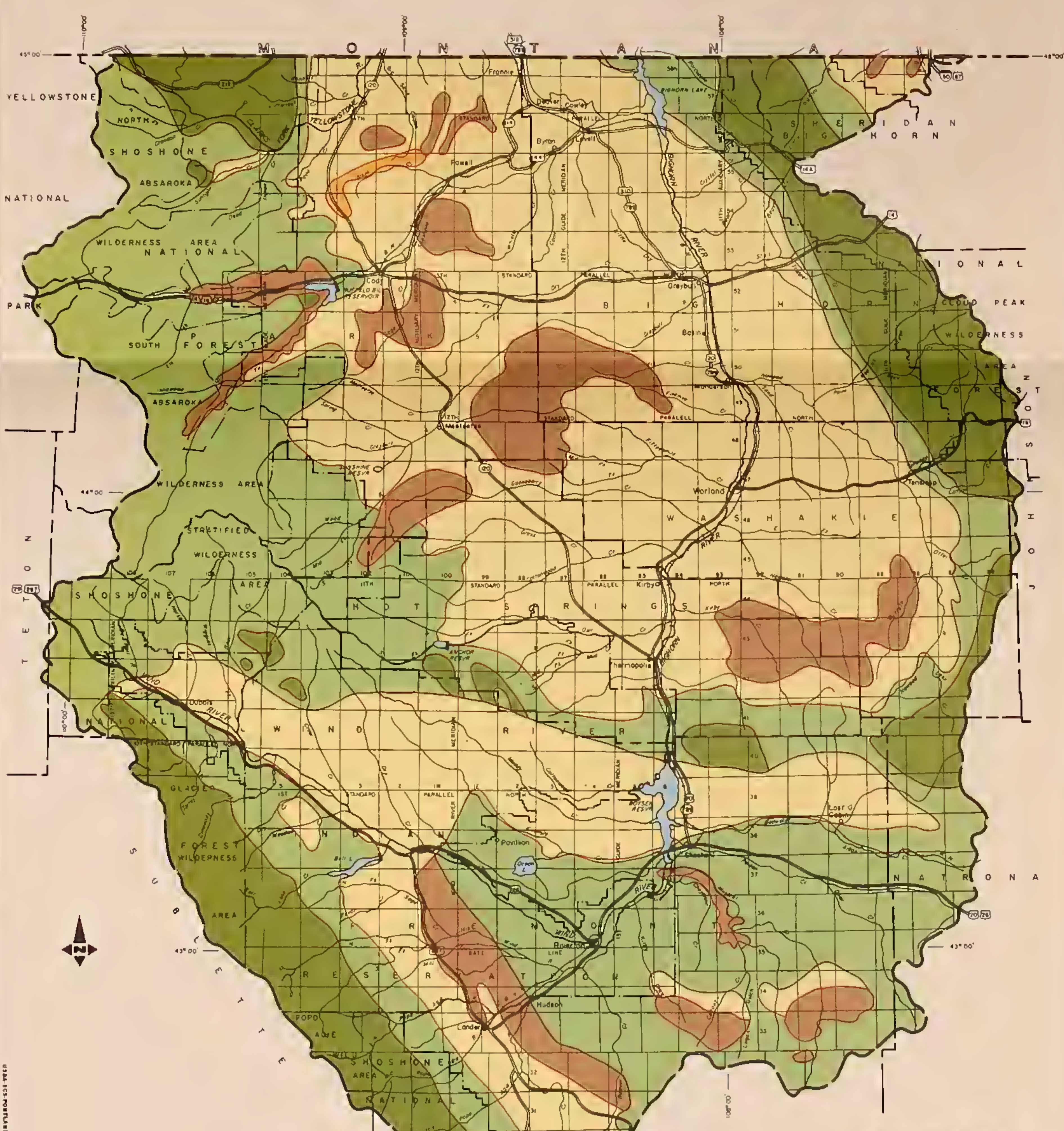
Inadequate control of irrigation tailwater can cause gully erosion.

Checking the depth of sediment deposits in Boysen Reservoir.

The town of Lander had serious floods before the river channel was cleared. The threat of an occasional flood still exists.

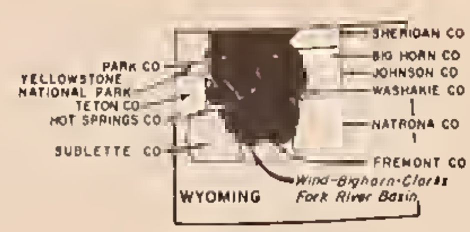
Floods in urban areas disrupt business as well as damage property.

PLATE 17



SEDIMENT YIELD
(Acre-feet per square mile per year)

- 1.0 – 3.0
- 0.5 – 1.0
- 0.2 – 0.5
- 0.05 – 0.2
- Less than 0.05



LOCATION MAP

FIGURE IV-1

SEDIMENT YIELD

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

USDA-SCS-PORTLAND, OREG. 1974

M7-N-22780L

uses are made more expensive in parts of the basin where the stream sediment load is heavy. Sediment usually must be removed before the water is usable. This is costly, and the sediment acts as an abrasive on pumping and control equipment, increasing the cost of maintenance.

Many kinds of capital improvements are damaged by sediment deposition. These include highway and railroad bridges which sometimes need to be raised or relocated due to channel capacity loss. Other permanent improvements such as streets, highways, and buildings are subject to damage by sedimentation.

Streams and rivers in the basin continually transport sediment in various amounts to reservoirs. The sediment is trapped in the reservoirs and reduces their water storage capacity. Table IV-2 lists estimated sediment yields to major reservoirs in the basin. In addition to tangible and environmental damages, excess sediment adversely affects the aesthetics of the streams.

FLOODWATER DAMAGES

Rare weather conditions, such as intensive summer storms or rapid snowmelt, will cause flood damages of varying degrees throughout the basin. However, severe flood damages are relatively infrequent. When smaller floods occur, they generally inundate only low valued properties and may actually have a beneficial effect on range or pastureland.

Table IV-2--Sediment yields to mainstem Bureau of Reclamation reservoirs based on suspended loads and/or reservoir surveys.

Reservoir	Average annual sediment yield	
	Total	Per square mile
	acre-feet	
Boysen Reservoir	1,398	0.18
Bighorn Reservoir		
Bighorn River yield	3,525	0.41
Shoshone River yield	746	0.50
Buffalo Bill Reservoir	708	0.48

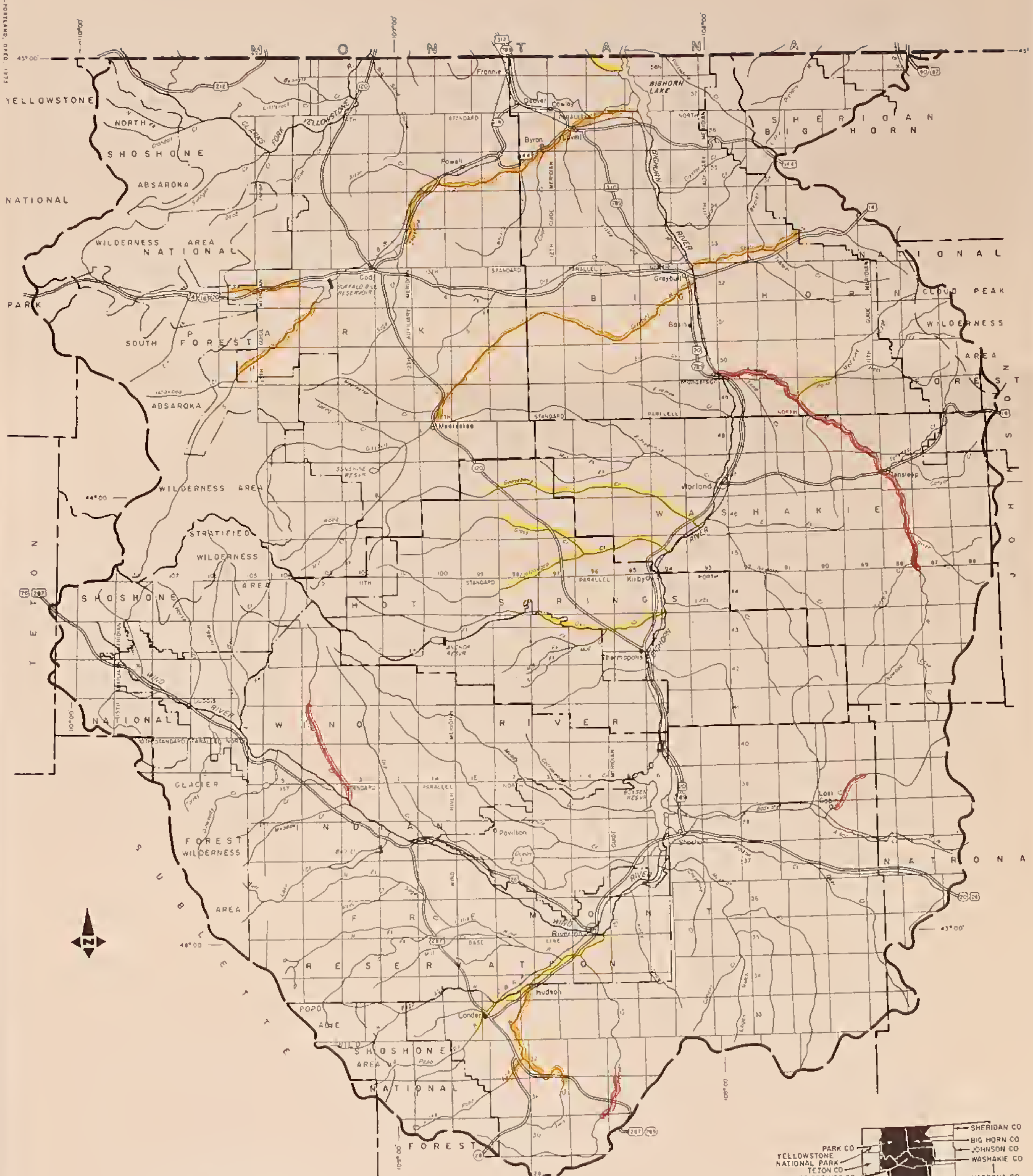
Agricultural properties along Crow Creek, Little Popo Agie, Upper Badwater Creek, Nowood River, Greybull River, Shell Creek, and Shoshone River are flooded frequently. Floodwaters in these areas have destroyed or severely damaged irrigation diversion structures. The delay in water application to the lands the structures serve causes reduced yield on lands outside the flood plain. Within the flooded areas crop yields are reduced. The most serious damage is usually to alfalfa and other hay crops. When floodwaters inundate these crops for prolonged periods, the plants are destroyed, and the crops must be reestablished. Thus, the damage is sustained for more than one year. Farm roads and bridges along the creek bottoms are often damaged or destroyed. Other agricultural damages occur to fences, stored hay, buildings, and machinery. Figure IV-2 is a map showing floodwater problem areas.

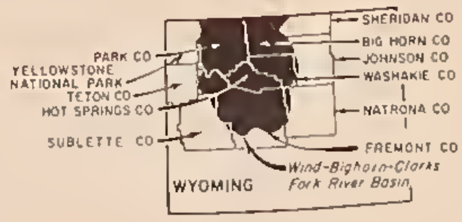
The most serious general flood occurred in 1923 when heavy rains continued over a sustained period with amounts up to 4 inches and caused general flooding throughout the basin. Flood occurrences of recent years are listed in table IV-3. Major floods occurred on several creeks in 1962, 1963, and 1967. Table IV-4 lists estimated average annual flood damages on four selected areas. The Nowood River area includes parts of seven watershed size areas. The other three are single watershed size.

The most serious rural flood problems occur along Shell Creek and along the Greybull and Shoshone Rivers. Some flooding occurs in these areas nearly every year. Higher flows inundate croplands and severely erode the banks damaging irrigation structures. Lands along the lower benches are left idle because of the frequent flood threats. The floods usually occur in June from a combination of snowmelt runoff and spring rain.

The most serious urban flood problems occur in Hudson, Lander, and Manderson. Both the Little and Middle Popo Agie Rivers have caused flood problems in the small town of Hudson. Because the town population is small and the value of property in the flood plain is relatively low, the average annual damage is only about $5,200. The most serious recent flood occurred in 1962 when 47 homes were damaged. Damages from that event were estimated to be about $52,000.

The town of Lander has had at least two serious floods from the Middle Popo Agie River, but because of the threat of flooding, the city has taken action to improve the hydraulic characteristics of the river channel through the city. Lander probably spends more each year for this flood control than any other town in the Wyoming part of this river basin. As long as this practice is maintained, only very rare floods can cause serious damage. New curbs and gutters and street paving have also improved the town's flood resistance. There are some lower lying properties along the river which should never be allowed to develop with new permanent dwellings or buildings of any kind. To allow this would be to further restrict the floodplain and make existing property more susceptible to flood damage.





LOCATION MAP

FLOODWATER PROBLEM AREAS

- Floods occur frequently; damages are moderate to severe. A potential flood protection or multiple-purpose project has been identified.
- Floods occur frequently; damages are moderate to severe. Physical characteristics, i.e. lack of storage sites, prohibit protection projects in the near future.
- Flooding problems exist; damageable values are low to moderate; preliminary studies have been made, but no feasible protection project has been identified.

NOTE: Red areas based on W.I.R.'s and watershed investigation studies. Orange and yellow areas are based on watershed investigation and newspaper accounts.

FIGURE IV-2

FLOODWATER PROBLEM AREAS
WIND - BIGHORN - CLARKS FORK RIVER BASIN
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
DECEMBER 1974

10 0 10 20 MILES
SCALE 1:1,000,000

M7-N-22780D

Floods in rural areas damage roads, buildings, and cropland.

PLATE 18

Some land with impaired drainage is presently cropland with limited production.

Most of the land described as poorly drained is presently of little use to either agriculture or wildlife.

PLATE 19

Table IV-3--Occurrence of major floods on selected watersheds, 1960-1970.

Watershed	Year										
	60	61	62	63	64	65	66	67	68	69	70
Crow Creek				M 1/		S 2/					
Little Popo Agie River			S	S		S				M	
Candy Jack	S		S	S				S			
Badwater Creek				M				M	S		
Nowood River			S	M		M		S			S
Greybull River		M	M	S	M	S		S	M	M	M
Shell Creek		S	S	S	M	S		M	S	M	M
Shoshone River		S	S	S		S		S	M		

1/ M = Moderate flooding - These floods were serious enough to be reported in local newspapers.
2/ S = Serious flooding - These floods were serious enough to merit special effort in reporting by the editor of the local newspaper.

Compiled from local newspaper accounts.

Both the Nowood and Bighorn Rivers have caused flooding in the small town of Manderson, which lies in the floodplain at the confluence of the two rivers. Average annual damages have been estimated to be about $39,500, of which 60 percent are from the Nowood and 40 percent from the Bighorn River.

Estimates of total flood damages in the entire basin were made for the Comprehensive Framework Study, Missouri River Basin. The estimates by subbasin are shown in table IV-5.

IMPAIRED DRAINAGE

All of the irrigated areas in the basin contain some wetlands. These areas are located on the floodplains and terraces along the larger streams. The wet condition is caused by impaired drainage associated with heavy soils or other soil barriers. This condition and lack of gradient restricts

Table IV-4--Estimated average annual flood damage on selected drainages

Major drainage	Flood-plain	Average annual damage				
		Crop & pasture	Other agricultural	Urban	Indirect	Total
	--acres--	dollars				
Crow Creek	40	170	9,580		975	10,725
Little Popo Agie	2,300	16,750	8,650	5,200	3,300	33,900
Upper Badwater	250	420	880		130	1,430
Nowood River	5,900	26,000	39,000	39,510	12,430	122,840

Table IV-5--Summary of current and projected flood damages 1/

Subbasin	Area subject to flooding	Average annual flood damage: Under current economic development	Under projected economic development (w/out flood protection) 2/: 1980	2000	2020
	-1,000 acres-	------------1,000 dollars-----------			
Clarks Fork Subbasin					
Main stem	.04	1	2	3	4
Tributaries	1.16	0	0	0	0
Subtotal	1.20	1	2	3	4
Wind River above Boysen					
Main stem	30.9	101	171	293	501
Tributaries	24.7	67	104	156	237
Subtotal	55.6	168	275	449	738
Bighorn River below Boysen					
Main stem	38.4	182	323	677	1,314
Tributaries	37.3	118	187	332	572
Subtotal	75.7	300	510	1,009	1,886
TOTAL	132.5	469	787	1,461	2,628

1/ Price base: 1964 price levels for agriculture, 1960 price levels for urban and "other rural."
2/ MRB data adjusted to reflect recent population projections.

the movement of water from the wet area to the drainageways. The wet areas are recharged by canal seepage, overapplication of irrigation water and precipitation. The depth of the water table is governed by the topography, transmissibility of the soils, rate of recharge, and depth and configuration of the underlying bedrock.

Salinity is associated with waterlogging and is aggravated by capillarity in the problem areas. Soil texture, hydrological properties, salinity, and temperature govern the height of capillary rise. Waterlogging and salinity problems will normally occur when the water table is within 4 to 5 feet of the surface. Many miles of tile and open drainage systems have been constructed. These systems have been installed in organized drainage districts and also outside of these districts with various types of federal technical and financial assistance.

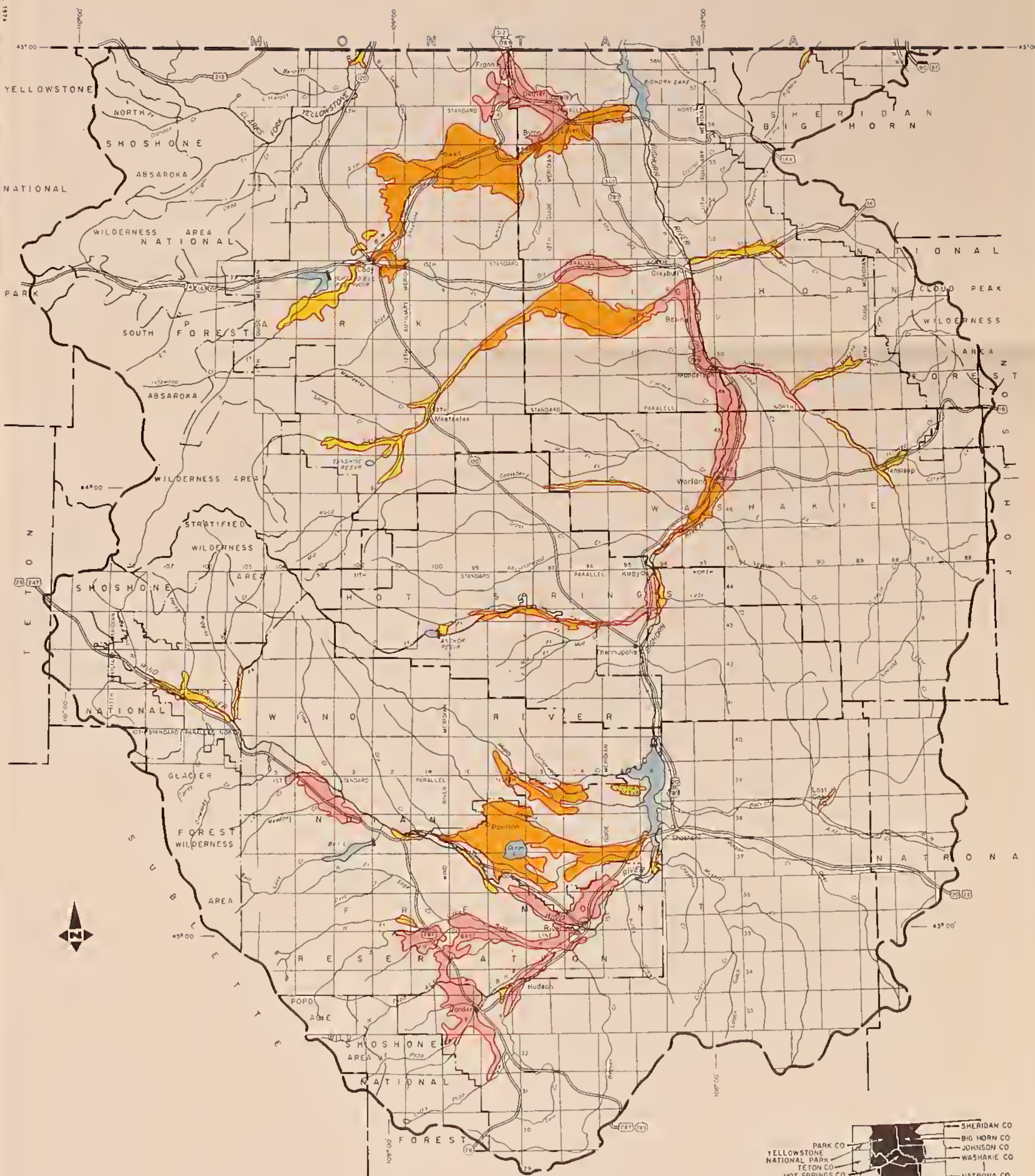
There are approximately 98,000 acres of wet and/or saline lands in the basin with the water table less than 6 feet below the surface. The Little Wind-Popo Agie area contains approximately 4,500 acres, the Wind River about 2,500 acres and the Riverton-Midvale-Muddy area about 37,000 acres of wet or saline lands. There are about 6,000 acres along the Bighorn and its tributaries excluding the Greybull and Shoshone Rivers. The Greybull River, including Emblem Bench, contains about 31,600 acres and the Upper Shoshone about 4,200 acres. The Lower Shoshone River and Sage Creek areas near Lovell contain about 11,500 acres of waterlogged and saline land. There are less than 500 acres of this type of problem area on the Clarks Fork and Little Bighorn Rivers. These data are estimates from an analysis of basic data as prepared for the 1970 Wyoming Conservation Needs Inventory. Figure IV-3 is a map of impaired drainage areas in the basin.

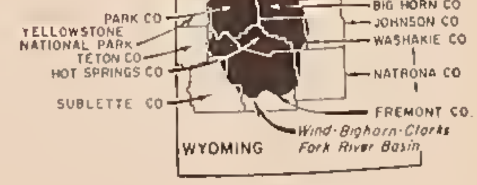
WATER SHORTAGES

Agricultural

Nearly all irrigated lands depend on stream flows for their irrigation supply. However, streamflow supplies are not generally concurrent with irrigation demands. Most of the streamflow comes from snowmelt from the higher elevations. The crop growing season in the lower elevations begins before high elevation snowmelt begins and continues after most of the snow has melted. The peak streamflow occurs as much as 10 weeks before the crops reach their peak water use rates, and then recedes more rapidly than the use rates. The problem that results is illustrated in figure IV-4 which shows demand-supply curves for a dry year in the Upper Nowood River area.

Irrigated croplands supplied with water from the larger streams have a good water supply, but late season water shortages still exist. One way to reduce these shortages is to provide reservoir storage of early season high flows for diversion later in the season. Buffalo Bill and Boysen Reservoirs have essentially satisfied the need for storage for





LOCATION MAP

IMPAIRED DRAINAGE
(percent of irrigated land with impaired drainage problem)

- 5% – 10%
- 10% – 25%
- 25% – 50%
- Over 50%
- Water

FIGURE IV-3

IMPAIRED DRAINAGE AREAS
WIND - BIGHORN - CLARKS FORK RIVER BASIN
WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

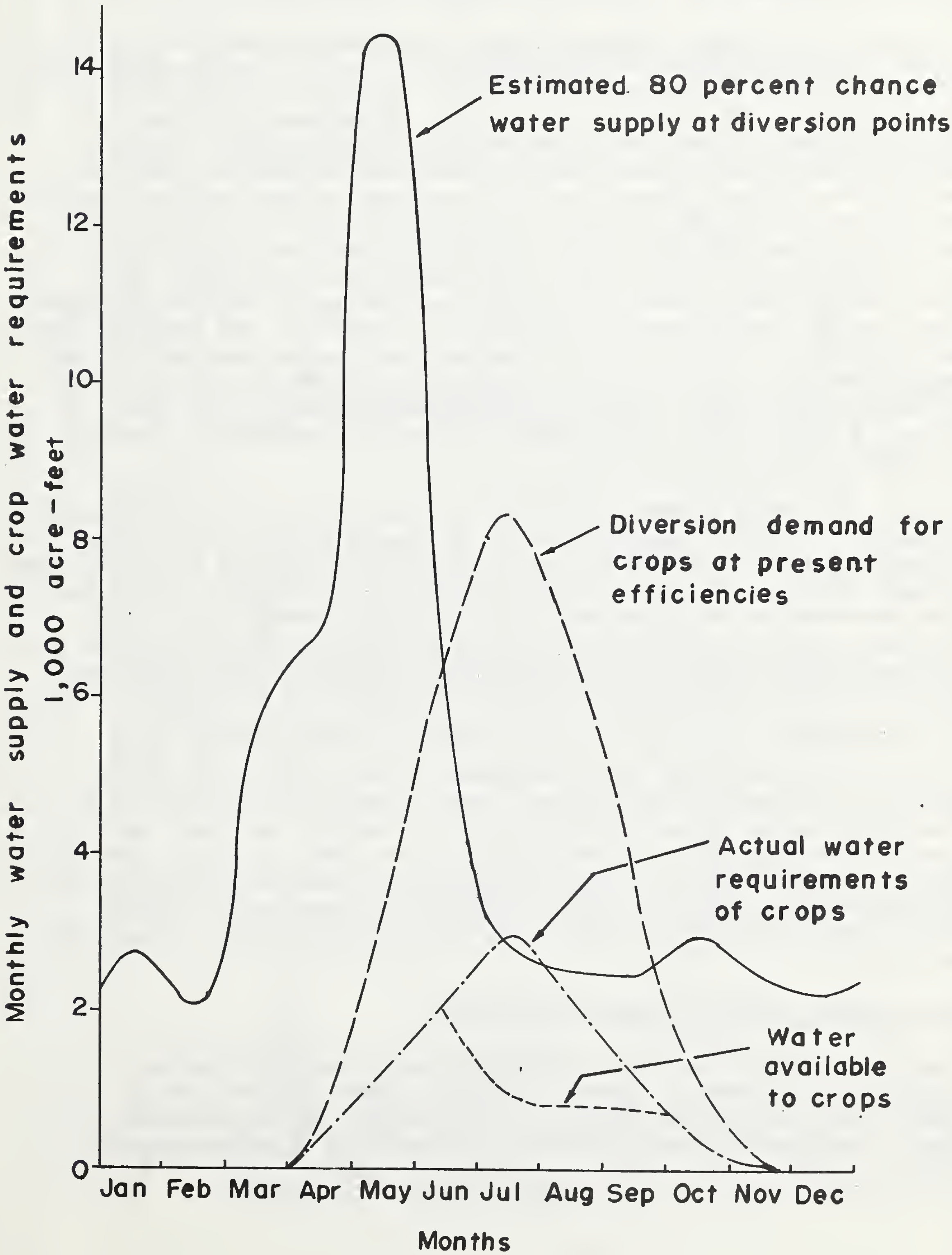
10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-N-22780K

Figure IV-4--Water supply and irrigation demand for the Nowood River above Tensleep, Wyoming



presently irrigated lands along the main stems of the Bighorn and Shoshone Rivers. Bull Lake and Pilot Butte Reservoirs serve the Riverton Reclamation Project. Water shortages that remain on lands served by these reservoirs exist largely because of inefficiencies in transportation and application of the water. In other large tributaries, irrigation water shortages are so small or potential storage sites would be so expensive that no sizeable storage facilities have been built.

In many of the small stream valleys, the annual streamflow is less than than the annual diversion requirements for full irrigation of present cropland. On a few streams the total annual streamflow would not supply these requirements if the water were used at 100 percent efficiency. This situation exists because landowners have developed their cropping patterns to use the early season high streamflows to increase total crop production, even though these crops suffer greatly reduced yields later in the season. The crops are generally hay crops which are cut only once a year. Increased water application efficiences will not significantly increase production in these areas unless additional late season water can be supplied. The situation might be improved and production increased through storage, but economical, geologically favorable, and large enough sites are generally not available. Some source of water must be obtained through intrabasin transfer or ground-water development if existing croplands in these areas are to have a full irrigation supply. In some instances, a water transfer could make a presently uneconomic reservoir site become economically attractive.

Table IV-6 shows a comparison of water supplies to water requirements for presently irrigated lands at present estimated project efficiencies for a median water year and a dry year. In dry years, which occur less than 20 in each 100 years (80 percent chance) there is a shortage of more than 359,960 acre-feet of irrigated water. If feasible storage sites could be provided, about 185,410 acre-feet of water could be stored from the spring runoff within water-short subareas in the basin. This means that at least 174,550 acre-feet would have to be transported from water-surplus areas to water-short areas if a full irrigation is to be supplied.

A related agricultural water management problem is the antiquated condition of irrigation distribution systems. Many existing facilities have deteriorated to the point of being barely usable, and they require much maintenance annually. Other facilities are simply obsolete, and the addition of modern control structures would allow improved transportation and management efficiencies. About 40 percent of presently irrigated lands are served by systems which are partially deteriorated, inadequate, or obsolete.

Livestock water and rural domestic shortages

Most ranch facilities are located near water supplies that are reliable even in periods of drought. Some of these supplies are of marginal quality and can be improved with treatment where economically feasible. The water storage problem is related to grazing management.

Table IV-6--Water supply shortages on presently irrigated land at present efficiencies

Name of hydrologic subarea	Watershed numbers	Present area of irrigated land	Irrigation water diversion requirement 1/	50 percent chance: Present water diversions 2/	50 percent chance: Need for stored or transferred water 3/	50 percent chance: Water supply at upper division point	50 percent chance: Storable water within water-short subareas 4/	50 percent chance: Transfer needs	80 percent chance: Present water diversions 2/	80 percent chance: Need for stored or transferred water 3/	80 percent chance: Water supply at upper division point	80 percent chance: Storable water within water-short subareas 4/	80 percent chance: Transfer needs
		acres	acre-feet	acre-feet					acre-feet				
Wind River above Dunoir	14el-1	1,996	8,290	8,290	0	126,900	- 5/	0	8,290	0	104,900	-	0
Horse Creek	14el-1a	2,423	10,000	10,000	0	47,000	-	0	10,000	0	43,000	-	0
Jakey's Fork, Torrey Crk, & misc.	14el-3	1,120	4,640	4,640	0	179,600	-	0	4,640	0	170,600	-	0
North and East Fork Wind River	14el-4	1,872	7,760	7,760	0	181,700	-	0	7,760	0	142,700	-	0
Dinwoody and misc. Creeks	14el-6	12,018	58,000	58,000	0	160,000	-	0	58,000	0	134,000	-	0
Mainstem Wind River above Burris	-	1,317	6,600	6,600	0	632,300 6/	-	0	6,600	0	532,300 6/	-	0
Crow Creek	14el-5	1,975	9,700	7,240	2,460	16,000	8,760	0	5,940	3,760	11,000	5,060	0
Bull Lake Creek	14el-7	725	3,830	3,830	0	192,400	-	0	3,830	0	156,400	-	0
Mainstem Wind River-Burris to Crowheart	-	1,958	9,700	9,700	0	889,400 6/	-	0	9,700	0	743,400 6/	-	0
Dry Creek	14el-8	521	2,700	1,910	790	4,230	2,320	0	1,450	1,250	2,670	1,220	30
Mainstem Wind River-Crowheart to Riverton	[illegible]	7,270	42,200	42,200	0	628,400 6/	-	0	42,200	0	466,000 6/	-	0
Riverton area canals	14el-10	10,895	94,400	94,400	0	536,200 6/	-	0	94,400	0	423,800 6/	-	0
Riverton Reclamation Project	14el-9	13,562	264,000	264,000	0	264,000 6/	-	0	264,000	0	264,000 6/	-	0
Fivemile Creek and Hurley Draw	14e-4	316	1,700	710	990	1,350	640	350	570	1,130	700	130	1,000
Sheep and Muddy Creeks	14e-5	1,484	8,000	3,400	4,600	4,300	900	3,700	2,300	5,700	2,800	500	5,200
Dry Muddy and Cottonwood Creek	14e-6	187	1,000	430	570	1,250	820	0	300	700	300	0	700
North, Middle, & Little Popo Agie	14ela-1, 2, & 2a	27,213	144,700	119,420	25,280	239,800	120,380	0	103,130	41,570	179,900	76,770	0
Little Wind, Sage, Trout, and Mill Creek	14ela-3, 4, & 4a	34,704	170,000	115,000	55,000	200,000	85,000	0	100,000	70,000	155,000	55,000	20,000
Beaver Creek	14ela-5 & 6	942	5,010	3,380	1,630	15,400	12,020	0	2,720	2,290	9,400	6,680	0
Badwater Creek	14e3-1, 2, 3, & 4	3,139	15,400	7,030	8,370	15,980	8,950	0	3,930	11,470	6,660	2,730	9,010
Mainstem Wind River-Riverton to Boysen	-	132	860	860	0	926,000 6/	-	0	860	0	642,400 6/	-	0
Subtotal for Wind River subbasin	-	195,769	868,490	768,800	99,690	-	-	4,050	730,620	137,870	-	-	35,940
Owl, Mud, & Red Canyon Creeks	14e-6a, 8, 8a, & 9	15,678	91,410	32,370	59,040	58,000	25,630	33,410 7/	22,320	69,090	40,000	17,680	51,410 7/
Buffalo, Kirby, & Nowater Creeks	14e7,10a,11,12,12a	384	1,220	930	950	1,750	820	130	620	1,200	990	310	890
Cottonwood and Grass Creek	14e-14 & 16	2,918	17,700	9,360	8,340	13,880	4,520	3,820	6,850	10,850	8,660	1,810	9,040
Gooseberry Creek	14e-15	3,818	24,810	9,280	15,530	10,610	1,330	14,200	5,880	18,930	6,700	820	18,110
Fifteen, Fivemile, & Elk Creeks	14e-19, 20, & 21	0	0	0	0	-	-	0	0	0	-	-	0
Nowood River above Tensleep	14e4-1, 2, 3	5,349	29,480	21,440	8,040	69,310	47,870	0	18,950	10,530	52,370	33,420	0
Tensleep and Canyon Creek	14e4-4	1,875	10,340	10,340	0	96,000	-	0	10,340	0	80,000	-	0
Brokenback Creek	14e4-5	619	3,400	3,390	10	16,000	15,610	0	3,290	110	14,000	10,710	0
Buffalo Creek	14e4-5	511	2,820	2,030	790	4,660	2,630	0	1,910	910	4,030	2,120	0
Paintrock & Medicine Lodge Creeks	14e4-6	5,884	32,430	30,230	2,200	121,110 6/	90,880	0	29,520	2,910	104,600 6/	75,080	0
Lower Nowood River	14e4-5, 7	4,929	33,400	33,400	0	271,090 6/	-	0	33,400	0	220,290 6/	-	0
Wood River and Dicks Creek	14e5-1	3,310	10,170	10,170	0	82,800	-	0	10,170	0	58,700	-	0
Greybull River above Meeteetse	14e5-1, 2, 3	5,790	27,500	27,500	0	126,840	-	0	27,100	400	96,840	69,740	0
Sunshine, Stonewall, and Rawhide Creeks	14e5-1 & 3	672	2,080	2,080	0	31,410 6/	-	0	2,080	0	28,080 6/	-	0
Lower Greybull River	14e5-3 & 4	41,616	206,280	173,550	32,730	231,890 6/	58,340	0	128,760	77,520	159,240 6/	30,480	47,040
Dry Creek	14e-5 & 14e5-4	13,868	63,000	57,800	5,200	57,800 6/	0	5,200	54,300	8,700	54,300 6/	0	8,700

Table IV-6--Water supply shortages (Continued)

Name of hydrologic subarea	Watershed numbers	Present area of irrigated land	Irrigation water diversion requirement 1/	50 percent chance					80 percent chance				
				Present water diversions 2/	Need for stored or transferred water 3/	Water supply at upper division point	Storable water within water-short subareas 4/	Transfer needs	Present water diversions 2/	Need for stored or transferred water 3/	Water supply at upper division point	Storable water within water-short subareas 4/	Transfer needs
		acres	acre-feet	acre-feet					acre-feet				
Upper Shell Creek	14e-22	401	2,210	2,210	0	67,300	-	0	2,210	0	57,200	-	0
Trapper Creek	14e-22	431	2,370	2,370	0	15,300	-	0	2,370	0	13,000	-	0
Horse Creek	14e-23	388	2,130	1,930	200	4,820	2,890	0	1,750	380	4,100	2,350	0
Red Canyon & Beaver Creeks	14e-23	2,033	11,240	6,300	4,940	9,200	2,900	2,040	5,900	5,340	7,820	1,920	3,420
Lower Shell Creek	14e-23	7,240	39,890	37,630	2,260	91,050 6/	53,420	0	34,660	5,230	77,040 6/	42,380	0
Bear Creek	14e-24	78	570	570	0	4,100	-	0	570	0	3,600	-	0
Mainstem Bighorn River-Boysen to Kane	-	61,579	347,000	347,000	0	925,000 6/	-	0	347,000	0	740,000 6/	-	0
North Fork Shoshone River	14e6a-1, 2, & 2a	1,977	10,900	10,900	0	617,310	-	0	10,900	0	508,810	-	0
South Fork Shoshone River	14e6-1, 2, & 3	23,641	130,310	130,310	0	480,570	-	0	130,250	60	396,100	265,850	0
Sage Creek	14e6-3	408	2,230	1,410	820	3,880 6/	2,470	0	1,110	1,120	2,530 6/	1,420	0
Shoshone River(includes Sage-Pryor)	14e6-5,6,7,8, & 8a	122,698	633,480	633,480	0	1,052,000 6/	-	0	633,480	0	857,700 6/	-	0
Crooked Creek	14e-27	1,079	7,160	5,090	2,070	9,910	4,820	0	4,520	2,640	7,710	3,190	0
Porcupine Creek	14e-28	329	1,630	1,630	0	24,740	-	0	1,630	0	19,280	-	0
Subtotal for Bighorn Subbasin	-	329,503	1,747,820	1,604,700	143,120	-	-	58,800	1,531,900	215,920	-	-	138,610
Sunlight Basin	14c-1	967	5,320	5,320	0	87,800	-	0	5,320	0	75,200	-	0
Crandall Creek	14c-2	303	1,670	1,670	0	166,600	-	0	1,670	0	142,800	-	0
Pat O'Hara Creek	14c-4	1,595	8,800	7,800	1,000	16,800	9,000	0	7,520	1,280	14,400	6,880	0
Cyclone Bar area	14c-5	3,679	20,240	20,240	0	73,300 6/	-	0	20,240	0	63,300 6/	-	0
Main Clarks Fork River	14c-3, 4, & 4a	4,575	25,200	25,200	0	356,600 6/	-	0	25,200	0	305,300 6/	-	0
Subtotal for Clarks Fork Subbasin	-	11,119	61,230	60,230	1,000	-	-	0	59,950	1,280	-	-	0
Little Bighorn River	14e7-1	163	810	810	0	104,000	-	0	810	0	86,000	-	0
Pass Creek	14e7-2	2,278	11,080	6,960	4,120	28,000	21,040	0	6,190	4,890	21,500	15,310	0
Subtotal for Little Bighorn Subbasin	-	2,441	11,890	7,770	4,120	132,000	21,040	0	7,000	4,890	107,500	15,310	0
Total for Basin	-	538,832	2,689,430	2,441,500	247,930	-	-	62,850	2,329,470	359,960	-	-	174,550

1/ Based on average annual consumptive uses and estimated existing irrigation project efficiencies.
2/ Diversions shown here do not exceed estimated diversion requirements. Actual diversions may exceed these amounts on streams where water supplies are not limited.
3/ The exercise of water rights may create additional storage needs in some cases.
4/ Figures in this column assume that all undiverted water is storable. Legal and environmental requirements will usually limit storage to smaller amounts.
5/ -means there is no applicable entry.
6/ This estimate includes return flows from upstream irrigated areas.
7/ The accuracy of this estimate is affected by several uncertainties involved in the effects of a recent local reclamation project.

Unherded cattle and sheep remain fairly close to water. Good grazing management requires that a suitable livestock water facility is established on each square mile of rangeland. About two-thirds of the rangeland in the basin is without these needed facilities.

Nonagricultural water shortages

Several of the towns in the basin have facilities and water supplies that are too small to meet peak demands in July and August. The common solution to this problem is to ration water for lawn and garden irrigation during this period.

PHREATOPHYTES

Phreatophytes are plants that generally obtain their water supply from very wet soils. Most phreatophytes have low economic value, and consequently, the water they use and return to the atmosphere may be defined as consumptive waste.

There are approximately 310 square miles of phreatophytes within the basin. Table IV-7 lists phreatophyte areas in the major subbasins in Wyoming. (Table II-11 listed phreatophyte areas within watersheds.) The predominant types of phreatophytes are sedges, rushes, greasewood, willows, and cottonwoods. Sedges, rushes, and willows occur mostly where they have invaded wet hay meadows, ditches, and streambanks. Cottonwoods extend along the full length of most of the streams in the basin. They generally grow in narrow banks, but they do cover broad areas between large stream meanders and stream junctions. Phreatophytes in the basin use an estimated 346,500 acre-feet of water per year.

There are no notable programs for control of phreatophytes in the basin. Some projects have been proposed, such as in the Bureau of Reclamation's Garland Division and in the lower Greybull River area. These projects involve the drainage of wet and phyreatophyte infested lands with their subsequent return to agricultural productivity. Most phreatophyte control has been at the local level, associated with canal and irrigation system renovation and on-farm land clearing and leveling.

The Wyoming Game and Fish Commission has developed two areas of heavy phreatophyte concentration as wildlife management units. Cottonwood trees provide very important deer habitat. Phreatophyte areas also provide habitat for antelope, waterfowl, small game, upland game, and livestock. Cottonwoods and willows along streams provide shade and cover for fish and other aquatic species and attractive recreation areas for man.

Table IV-7--Phreatophyte areas

Subbasin	Area
	----square miles----
Wind River	118.8
Bighorn	186.5
Clarks Fork	4.7
Little Bighorn	0
TOTAL	310.0

POLLUTION

Pollution and water quality are interrelated, and high water quality usually indicates a lack of pollution. However, if flow volumes in the receiving stream are high, and if the pollutant discharge is biodegradable and is not great, it is possible that the stream system can accept the pollutant discharge without a significant drop in water quality.

Municipal and industrial waste water sources in the basin tend to be unique in character because of the paucity of manufacturing processes in the basin. As a result, the wastes are usually domestic in character, and lend themselves to treatment, stabilization, or full retention. In only one case is there a greater than acceptable biological burden, and this discharge is presently under a plan of implementation for full abatement. Most other municipal, industrial, and commercial discharges are assimilated by the receiving stream with only negligible water quality effects. The significant deviation from this situation is the widespread existence of oil and gas wells. These wells often produce significant amounts of heavily-mineralized and oil-laden water. The industrial practice is to provide a primary oil separation treatment to these waters before releasing this water to the environment. These wells are located in a generally arid basin and contribute water, albeit mineralized, that is used for stock water and irrigation. When not used in this manner, the discharge usually evaporates or seeps into the soil before reaching a live stream. In those cases where discharges have adversely affected downstream water uses, abatement measures have been initiated by the Wyoming Game and Fish Commission, the State Health Department, and other agencies.

Sediment pollution has been discussed under sediment damages earlier in this chapter.

Pollution from recreational facilities is generally low because of proper use, operation, and maintenance of private, state, and federal facilities. However, improper, clandestine, uncontrolled access, and improper vehicular or recreational use of such areas can generate serious biological, mineral, and sediment burdens to the watershed. Off-road vehicles can be especially damaging to the land and can cause serious erosion problems which add a mineral and sediment burden to the basin's water.

Some developed recreation sites on the national forests are being damaged by over-use. The campgrounds and picnic areas are used heavily during the summer months. Sites on the Wapiti Ranger District suffer from spillover use from Yellowstone National Park. Soil compaction, reduction of vegetative cover, accelerated erosion, and increased sediment production are occurring. Water pollution by garbage, silt, organic wastes, and chemicals such as oil and gasoline is becoming more serious.

Wilderness areas suffer damage from riding stock and trail riders. Alpine tundra, meadows, and bogs are particularly susceptible. Increased human and animal use of some wilderness areas is causing health and sanitation problems.

Agricultural production contributes to water pollution through irrigation return flows, cropland erosion, feedlot runoff, and improper grazing practices.

RELATIONSHIP OF WATER PROBLEMS TO IMPAIRMENT OF NATURAL BEAUTY

Some of the most scenic areas in the west are found in this river basin. High, rugged mountains with their glaciers, evergreen forests, grass-covered hills, and clear mountain streams are present. However, some tributary streams that once were clear are now clouded by soil losses from accelerated erosion. Some large reservoirs contain suspended solids and other pollutants during spring runoff periods which detract from their attractiveness for boating, fishing, swimming, and other similar pursuits.

Some tributary streams such as Badwater Creek which once flowed through grassy meadows are now gullied channels. Periodic flooding on major streams causes channel changes, bank erosion, and channel scouring.

OTHER FOREST-RELATED PROBLEMS

Insect and disease damages are high on most forest types. It is estimated that up to 50 percent of the gross annual timber growth may be lost to insects and diseases. Mountain pine beetle, douglas-fir beetle,

and spruce budworm are endemic insects in nearly all stands. Major diseases causing loss are dwarf mistletoe, commandra rust, butt rot, and heart rot.

Range and forest fires occur often and there is a cyclic pattern in the occurrence of large fires. About 150 fires burn over 8,900 acres in the basin each year. The majority of the fires are small and result in relatively minor damages. Large, disastrous fires occur periodically and cause significant economic and environmental damage.

Some major problems which could contribute to disastrous fires are (1) a heavy accumulation of logging debris and slash on some areas, (2) extensive stands of overmature timber, and (3) large areas of insect damaged timber. Other factors contributing to fire problems include heavy buildup of fuel on areas long protected from fire; increased use by hunters, recreationists, and other users of forest resources; and a lack of organized fire protection for private land in some counties.

Timber losses due to insects, diseases, and animal and mechanical damage are significant on large areas of overmature forest. In addition, overstory suppression causes reduced growth rates on thousands of acres of seedlings and saplings.

Another major problem is the lack of adequate regeneration as a result of damage from livestock, wildlife damage, insufficient summer moisture, the large size of some nonstocked areas, and erosion of the thin young soil. The Paint Creek and Pat O'Hara Creek watershed areas have particularly severe problems.

Overgrazing, poor stocking of vegetation, and concentrations of noxious and poisonous plants damage rangelands and prevent full production and use of grazing resources on national forest land.

Full use of forest recreation resources is inhibited by the lack of developed facilities and sites, inadequate road networks, insufficient trails development, and uneven geographic distribution of lakes, reservoirs, and other water developments.

FISH AND WILDLIFE HABITAT PROBLEMS

Historically, loss and degradation of habitat is the primary problem related to fish and wildlife. This loss and degradation has been largely compensated for by aquisition and management of key winter ranges for big game, hunting and fishing easements on private lands, and construction and protection of nesting areas for waterfowl.

Big game

Winter habitat is the main limiting factor for big game. Decreases in winter habitat have resulted from development of minerals, highways,

agriculture, recreation, and other human activities. Specific problem areas are described below.

a. Open pit mining and increased mineral exploration has decreased some winter habitat in the Gas Hills Mining District southeast of Lander.

b. Lack of watering facilities in the "badlands" in the central portion of the Bighorn Basin limits wildlife use of these areas.

c. Fencing throughout the basin somewhat restricts migration and distribution of big game. Overgrazing by livestock in some areas limits food for elk and deer both in summer and winter.

d. Artificial reduction of sagebrush and willow in large blocks has reduced some winter habitat for moose, deer, sage grouse, and antelope. The effects of big sagebrush management in any location should be carefully evaluated before applied.

e. Moose habitat in the basin is very limited and should be carefully evaluated before developing any large reservoirs.

f. Increasing numbers of people using motorized vehicles during all seasons of the year have increased pressure on big game in some critical areas such as in the Big Horn Mountains near Shell Creek and in the Wind River Mountains near Union Pass.

Upland and small game

Intensive agriculture has affected upland and small game more than any other species of wildlife. A change in agricultural practices can benefit some species while adversely affecting others. For example, cropped areas improve habitat for pheasant, quail, ducks, and rabbits, but drastically decrease habitat for sage grouse.

However, some agricultural practices decrease habitat for all wildlife on agricultural lands. Lining ditches with concrete, clean farming, the use of pesticides, and grazing and clearing windbreaks are examples of such practices.

Sage grouse habitat is reduced because of sagebrush control and mining operations. Lack of watering facilities also affects upland and small game distribution.

Waterfowl

Waterfowl habitat is limited in the basin by lack of nesting and feeding areas.

Furbearers

Furbearers generally require heavy cover along streams. Much of this habitat has been removed through agricultural practices, road building, and other activities.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

Water and related land resources of the basin need to be managed and developed to minimize present problems and alleviate present and future needs. Demands on these resources will increase due to greater use by both residents and nonresidents. Practices and measures needed to protect and improve the management and use of these resources are discussed in this chapter. As land and water are used more intensively, all landowners should be concerned that existing abuses are stopped and that new uses are properly planned, carefully applied, and wisely managed.

NEEDS FOR WATERSHED PROTECTION AND MANAGEMENT

General

There are about 13,179,000 acres of land and water in the Wyoming portion of this river basin. About 5,115,000 acres of land are owned by the state and by private owners. Table V-1 lists estimated needs for conservation practices for state and private lands as presently used. If some irrigable lands are developed into irrigated lands, they will need all of the practices listed for irrigated lands.

The first line in table V-1 includes estimates of areas where the present level of conservation treatment is adequate. This means that needed structural measures are installed, management and cultural practices are implemented, and water is efficiently used. However, there is still a need to continue the existing level of management and to maintain existing systems or replace them as they wear out.

Improved treatment needed on irrigated croplands

About 80 percent of the irrigated land in the basin needs some kind of improvement of structural systems, cultural management, 1/ water management, or a combination of improvements to achieve proper conservation use. The principal need is for improved irrigation and drainage systems. These include land leveling, channel lining, control structures, pipelines, sprinkler systems, tailwater recovery systems, and drainage systems. Needs for drainage are discussed in more detail later in this chapter.

Where system improvement is needed, proper management of water is difficult, if not impossible. It is also true that structural systems must be properly managed in coordination with other practices to achieve their full potential. About 40 percent (217,240 acres) of the irrigated land needs the complete treatment of improved cultural management, water management, and irrigation systems.

1/ Cultural management includes, but is not limited to, such practices as rotation cropping, minimum tillage, stubble mulching, contour furrowing, and rotation grazing.

Table V-1--Conservation treatment needs on state and private lands with present land use 1/

Kinds of conservation treatment needed	Irrigated cropland	Other cropland	Pasture and rangeland 2/	Non-federal forest	Other agricultural	Total
	acres					
Present treatment adequate or treatment infeasible	107,820	1,233	1,436,350	251,690	43,360	1,840,453
Improved treatment needed on irrigated land:						
Irrigation and/or drainage systems	217,240					217,240
Water and cultural management	159,940					159,940
Cultural management only	53,830					53,830
Improved treatment needed on non-irrigated cropland:						
Erosion control		2,283				2,283
Soil maintenance and improvement		554				554
Improved treatment needed on range and dry pasture:						
Proper grazing use and planned grazing systems only			2,156,810			2,156,810
Accelerated range improvement:						
Brush and weed control			555,600			555,600
Reseeding			7,400			7,400
Range renovation			13,890			13,890
Improved treatment needed on forested land:						
Disease and weed control				80,970		80,970
Reduction of grazing				7,640		7,640
Revegetation needed on other agricultural lands					18,600	18,600
Total	538,830	4,070	4,170,050	340,300	61,960	5,115,210 3/

1/ Compiled from "Wyoming Conservation Needs Inventory," 1970, Soil Conservation Service and U.S. Forest Service inventories.

2/ All irrigated pasture is included in cropland.

3/ Does not include 144,850 acres of water and state and private lands in non-agricultural uses.

Among the important conservation needs in the basin are improved irrigation water delivery structures, tailwater recovery structures, and improved water management on the fields.

PLATE 20

Rhizomatous wheatgrasses are native to rangelands in the basin. Good healthy grasses are food for livestock and wildlife and cover for birds and other small animals. Grasses improve soil structure, prevent soil erosion, and increase soil moisture by reducing losses of snow and rainfall.

About 80 percent of the private and state land in the basin is rangeland. The primary range conservation need is improved grazing systems and management.

About 14 percent of the rangeland needs brush management and weed control.

Grass for livestock is not enough. Wildlife habitat needs must be properly considered.

A well-balanced plant community is needed to provide for a variety of life.

PLATE 22

There wasn't enough water to provide a second irrigation. Both supplemental water supplies and improved irrigation efficiencies are needed.

Only about one-third of the livestock water supplies needed to improve range use have been developed.

On about 30 percent of the irrigated cropland an acceptable water control system exists, but both water and cultural management need to be improved. On about 10 percent of the irrigated land a good system exists, good water management is practiced, but cultural management still needs to be improved.

Improved treatment needed on nonirrigated croplands

There are only about 4,070 acres of nonirrigated cropland in this basin in Wyoming, and this is all in the Little Bighorn portion of Sheridan County. About 60 percent of this area needs some conservation treatment to improve the soil and prevent erosion.

Improved treatment needed on rangeland and dry pasture

About 73 percent of the river basin is rangeland and dry pasture. About 58 percent of this is in federal land. Federal resource management programs are directed at maintaining and improving vegetative cover on these lands and are discussed in other portions of the report. The remaining 42 percent is state and privately owned and represents about 81 percent of all state and private lands. About 66 percent of state and private rangeland needs improved conservation treatment.

Erosion is the most significant problem on private and state rangelands. If these lands are properly vegetated, there will be little need for structural works for erosion control and the overall productivity will increase. Vegetation can generally be improved in a reasonable time through good grazing management practices alone. Increased use of these practices is the principal conservation need on range and dry pasturelands. Some of the needed practices are rotation grazing, rotation deferred grazing, stockwater developments, and fencing. About 52 percent of nonfederal range and dry pasturelands need these practices.

When the practices mentioned above cannot improve the vegetative cover effectively or in reasonable time, accelerated chemical or mechanical range improvement practices are needed. These practices include brush and weed control, reseeding, and range renovation. About 14 percent of the state and private range and dry pasturelands in the basin need accelerated chemical or mechanical range improvement practices.

Nonfederal forest lands

About 3 percent of the basin is nonfederal forest land. Approximately 25 percent of this land needs improved conservation treatment. Federal and nonfederal forest land development and improvement needs are discussed together, later in this chapter.

Other private and state land

About 30 percent of the small area of land in miscellaneous uses needs revegetation treatment.

FLOOD PROTECTION AND SEDIMENT CONTROL NEEDS

Protection from damaging floodwaters is needed on most of the principal tributaries of the Bighorn River and on isolated tributaries of the Wind River. Floodwaters and sediment deposits along those streams have caused damage to homes, crops, livestock, agricultural improvements, and wildlife. Where more frequent flooding has occurred, lands have been left idle or have been abandoned. The following specific areas have been identified as needing protection:

a. Crow Creek: Protection is needed along the lower reaches of the creek to protect irrigation diversion structures, croplands, farm buildings, livestock, and wildlife.

b. Beaver Creek: Damages along the creeks are relatively low, but cost of protection would also be relatively low. Protection is needed for irrigation structures and croplands.

c. Badwater Creek: Protection is needed in Upper Badwater Creek to reduce streambank erosion and flooding of croplands. Damages are relatively low, but the cost of providing protection in a multi-purpose structure would also be relatively inexpensive.

d. Little Popo Agie: Protection is needed from above the confluence of this river and Twin Creek down to the Popo Agie River. The most urgent protection is needed in Lyons Valley where floodwaters have damaged crops, farm buildings, irrigation structures, livestock, and have seriously damaged pheasant habitat and in the town of Hudson where floods have damaged homes, commercial property, and roads.

e. Nowood River: Protection is needed for the agricultural lands from Big Trails to Manderson and in the town of Manderson. Prolonged flooding conditions have damaged crops, irrigation structures, roads, bridges, wildlife habitat, and caused severe streambank erosion. Structural measures are needed in the town of Manderson to protect homes, the school, commercial properties, and streets. Structural measures are also needed along much of the Nowood River channel to protect the banks from erosion.

f. Greybull River: Structural and land treatment measures are needed to protect agricultural lands, irrigation structures, wildlife habitat, and roads and bridges along the river from above Meeteetse to the Bighorn River. Frequent channel changes during high flows have destroyed croplands, wildlife habitat, and left irrigation diversion structures inoperable.

g. Shell Creek: Structural and land treatment measures are needed to reduce floodwater damages to agricultural properties and reduce streambank erosion. Floodwater flows have damaged croplands, wildlife habitat, and aesthetic qualities of one of the most scenic creeks in the basin.

h. Shoshone River: Land treatment and structural measures are needed to reduce floodwater and streambank erosion damages along the South Fork above Buffalo Bill Reservoir and on tributaries of the North Fork above the reservoir. Floodwaters on the South Fork have damaged crops, farm buildings, irrigation structures, wildlife habitat, and caused severe streambank erosion. Land treatment measures are needed in the forested and rangeland areas to reduce runoff and along the streams to reduce bank erosion. Floodwater damages on North Fork occur primarily along the tributaries and damage crops, homes, commercial properties, and roads. The unstable nature of the channels and topography of the watersheds would reduce the effectiveness of structural programs. Land treatment measures in the upper watersheds would thus be the most efficient means of protecting the lands below. Floods along the Lower Shoshone cause frequent damage to agricultural properties, wildlife habitat, and cause serious streambank erosion. Structural and land treatment measures are needed to reduce flows and stabilize the channel.

Damages from floodwater also occur in other smaller areas in the basin and may require land treatment or small structural measures to provide needed protection.

GULLY AND STREAMBANK STABILIZATION NEEDS

The 1970 Conservation Needs Inventory lists approximately 70,000 acres of private range and croplands in the basin as having a serious erosion problem. These unstable areas need structural control practices to protect the land during storms, control the runoff, and dispose of irrigation waste flows at nonerosive velocities in addition to the watershed protection and management needs discussed earlier in this chapter. Gully plugs, terraces, floodwater diversions, chiseling and subsoiling, critical area planting, and mulching are examples of practices needed on these lands.

Much of the 70,000 acres are affected by unstable channels in the basin. About 1,200 streambank miles are presently unstable and erode more each year during periods of high flow. About half this mileage is on small tributaries of the larger streams. Many of these are intermittent streams. Practices needed on the tributaries include grade stabilization structures, debris basins, channel stabilization, streambank protection, clearing and snagging, and grassed waterways. The critical areas needing these practices are portions of upper Wind River, Popo Agie tributaries, Beaver Creek, Fivemile Creek, Bridger Creek, upper Nowood River, upper Greybull tributaries, tributaries of the Shoshone River, and Sunlight Creek.

The remaining 600 miles of eroding streambank are along larger streams. Practices needed to reduce this erosion include streambank protection, channel

stabilization, clearing and snagging, diversion dams, flood and sediment retarding dams, dikes, and gradient stabilization structures for irrigation return flows. Critical areas needing these practices are found on the lower portions of Little Wind River, Popo Agie River, Badwater Creek, Muskrat Creek, Nowood River, Greybull River, Sage Creek, Nowater Creek, Cottonwood Creek, Gooseberry Creek, Shell Creek, Kirby Creek, Pat O'Hara, and Paint Creek.

If applied, conservation practices shown in table V-1 will also help reduce gully and streambank erosion by reducing surface runoff rates, thus reducing erosive energy in the basin's streams.

Artificial as well as natural channels need to be stabilized. One of the most critical of these is the Enterprise Ditch near Beason Creek near Lander.

DRAINAGE IMPROVEMENT NEEDS

There are approximately 98,000 acres of wet and saline cropland in the basin. Subsurface drainage and improvement of conveyance systems and on-farm irrigation water management is needed to improve conditions on this land. Canal and ditch lining is needed to prevent recharge from seepage, and improved irrigation water management is needed to maintain a salt balance and improve crop production.

Surface drains are needed in some of the wet mountain meadow areas in the high, irrigated valleys along the upper reaches of the Wind-Bighorn-Clarks Fork Rivers and their tributaries. The soils in these areas are generally shallow and non-saline, the fields are small and uneven, and the wet areas are usually restricted to small, extremely boggy spots.

The most critical areas in need of drainage are the Midvale-Pavillion, north Worland, Burlington-Otto, Deaver-Frannie, and north Powell areas where deep, fine-textured, wet and saline soils occur. Other important areas are located along the Wind River, Little Wind River, and Popo Agie Rivers, Owl Creek, Nowood River, the lower South Fork of Shoshone River, and along the Bighorn River near Kane. Drainage is needed in the remainder of the irrigated areas in the basin where more shallow and more permeable soils transmit irrigation percolation losses to adjacent lower lands. Additional drainage will also be needed as new land is brought under irrigation.

Many miles of open, subsurface drains have been installed in the past. Most of these drains need rehabilitation or replacement by tile line systems.

NEEDS FOR IRRIGATION WATER

Agriculture and businesses dependent on agriculture account for most of the economic activity in the river basin. This situation is expected to exist in the future. Underemployment, low per capita income,

and high outmigration rates are economic and social problems discussed earlier in this report. There is a need to reduce these problems in the region. This can be done by increasing and stabilizing farm incomes through increased agricultural production.

Any increase in crop production also increases the consumptive use of water by those crops. Where the water presently available to a crop is less than its potential consumptive use, an increase of water supply alone will increase production. Some of this water can be applied without increasing irrigation water diversions. This is called increased efficiency. Improved irrigation systems and improved management of water will reduce tailwater, percolation, and evaporation as well as improve the uniformity of water distribution on the field. This is discussed in more detail earlier in this chapter. It is painful to learn, however, that this approach seems to have the least effect on production where water supplies are shortest and where present field irrigation efficiencies appear to be the lowest. In much of the river basin, especially in its central portion along smaller streams, improved field efficiencies cannot provide for a significant increase in crop production. These areas need additional late season water supplies from storage reservoirs, wells, or intra-basin transfers of water if production is to be increased. Only when these supplemental supplies are provided will the benefits exceed the costs of improved water management.

There are about 538,800 acres presently irrigated. About 182,000 acres are in water-short areas where about 359,960 acre-feet of supplemental water is needed per year in dry years. See table IV-6.

As stated in chapter 3, irrigated land is expected to increase from 538,800 acres to 600,100 acres by 2020. This is an increase of 61,300 acres. These new irrigated lands will need about 130,000 acre-feet of water per year for consumptive irrigation requirements. If this water is used at 50 percent efficiency, the diversion requirement will be about 260,000 acre-feet per year.

FOREST LAND DEVELOPMENT NEEDS

Forest land development needs are listed in table V-2 for all forested land in the basin. The state and private forested land treatment needs shown in table V-1 are also included in this table.

Projections of economic activity for the nation, region, and basin show a need to increase timber production. In order to meet expected demands, the supply of timber available for harvesting needs to be increased 12 percent in 1980, 31 percent in 2000, and 39 percent in 2020.

Planting or seeding is needed to reforest or regenerate 9,600 acres of forest land. This will reduce accelerated erosion and sediment production, improve hydrologic conditions, and contribute to long-range satisfaction of timber needs.

Table V-2--Forest and rangeland development needs by ownership, Wind-Bighorn-Clarks Fork River Basin, Wyoming

Development need	Unit	Amount and ownership: National Forest	Public domain	Wind River Indian Reservation	State & private	Total 1/
Range revegetation						
Plant control, type conversion	acres	36,600	37,300 2/	253,000	NA 3/	326,900
Range distribution trails	miles	190	350	0	NA	540
Range fences	miles	625	1,000	0	NA	1,625
Range water developments	each	325	2,010	80	NA	2,415
Planting or seeding	acres	6,400	2,000	600	600	9,600
Timber management:						
Insect control	acres	51,300	5,000	0	30,000	86,300
Disease control	acres	140,000	0	12,600	0	152,600
Release, harvest, thin, and weed	acres	74,500	0	10,000	108,000	192,500
Fishing stream improvement	miles	820	NA	NA	NA	NA
Fishing lake improvement	acres	4,750	"	"	"	"
Wildlife habitat management	acres	11,700	"	"	"	"
Fence Key Wildlife Areas	miles	60	"	"	"	"
Trail construction and improvement	miles	1,700	"	"	"	"
Road construction and improvement	miles	1,720	"	"	"	"
Roadside observation sites	each	40	"	"	"	"
Erosion control:						
Gullies	miles	125	"	"	"	"
Sheet erosion	acres	4,100	"	"	"	"
Abandoned roads and trails	miles	260	"	"	"	"
Streambank stabilization	miles	30	"	"	"	"
Mining control and restoration	acres	25	"	"	"	"
Snowpack management, Alpine	miles	65	"	"	"	"
Recreation site improvement	acres	1,150	"	"	"	"

1/ More than one practice may be needed on a given acre of land.

2/ Treatment planned - total needs are not known.

3/ NA means data are not available.

About 192,500 acres of over-mature forest stands need to be harvested and regenerated or given salvage and sanitation cuts. This will solve problems of decadence and excessive losses from insects and diseases on these areas. Timber supplies can be significantly increased, and grazing and wildlife resources can be improved.

Thinning, weeding, release cutting, pruning, and other cultural treatment is needed to reduce fuel accumulations, improve growth, and combat insects and diseases on 238,900 acres.

Range seeding, proper herding and distribution, control of noxious and poisonous plants, stockwater developments, and range fencing are needed to improve forage and meet demands for forest land grazing. Type conversion, plant control, and revegetation is needed on about 326,900 acres. About 1,625 miles of fencing to control grazing, 2,415 stock reservoirs, and 540 miles of stock distribution trails are needed.

There is a need for restoration and habitat improvement on 820 miles of streams and 4,700 acres of lakes on national forest land. About 30 miles of streams need treatment to stabilize banks and reduce sediment loads.

Management needs of terrestrial wildlife habitat include wildlife openings and food patches, thinning of dense, stagnated timber stands, openings and trailways in timber, and cover strips in cleared forest areas. On national forest land about 11,700 acres of wildlife habitat restoration and improvement and 60 miles of fencing are needed. Special management and protection is needed to sustain several rare and endangered species.

Fire prevention and control measures are needed to reduce the number, size, and intensity of range and forest fires. Some of these needs are reduction of fuel and logging debris, salvage of insect damaged stands, improved fire detection, additional fire weather stations, intensification of aerial fire control, increased use of prescribed burning to reduce fuels and other hazards, hazard reduction along roads and trails, expansion of state protection to private lands not now covered, and improved coordination between suppression agencies.

Roads, trails, mines and excavations, overgrazed areas, and areas damaged by off-road travel need erosion control measures, revegetation, and hydrologic improvement. On national forest land sheet erosion control is needed on 4,100 acres, 125 miles of gullies need control, 260 miles of eroding roads and trails need rehabilitation, and 25 acres of eroding mine areas need treatment.

There is a need for additional development of recreation sites to alleviate seasonal over-use and deterioration of sites and to satisfy projected recreation demands.

An adequate system of roads and trails is needed to develop, manage, and protect forest resources. Construction and reconstruction is needed on about 1,720 miles of forest roads. Included is a network of low-speed, high standards scenic roads with more than 40 scenic observation sites. About 1,700 miles of recreation trails for backpack hiking, horseback riding, trail bike and snowmobile use, and walking for pleasure are needed.

RURAL, DOMESTIC, AND LIVESTOCK WATER SUPPLY NEEDS

The primary need for new water supplies is associated with proper range management. As a rule of thumb there should be some watering facility for livestock in each square mile of rangeland to promote even distribution of grazing pressure. Surface water in streams, ponds, and springs is not distributed well enough to provide the needed supply. More wells, spring developments, and ponds need to be developed. Only about one-third of the needed watering places have been developed on rangelands in the basin.

Ground-water wells and springs are principal sources for farmsteads and small communities. Surface streams and ponds are also important supplies. In some areas both surface and ground-water supplies are highly mineralized. In other areas surface supplies are very limited, and ground-water aquifers lie deep underground. In these areas it is necessary to transport water for domestic and livestock purposes.

Usually, more of the livestock water supply is evaporated than is used by the livestock. Estimated average water needs for evaporation and consumption by livestock are about 40 gallons per day per animal unit. Domestic needs can vary from 5 to 150 gallons per day per person depending on the manner and number of uses involved. An estimate of average rural domestic use per person might be 60 gallons per day.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY NEEDS

Some towns have a need to enlarge and improve their water supply systems to replace old systems or to handle population expansion. Present industries have developed suitable supplies, but new industries need to consider water supply problems in their chosen potential sites.

RECREATION NEEDS

Recreation is an important use of water and related land resources in the basin and the surrounding area. Yellowstone and Grand Teton National Parks, Big Horn Canyon National Recreation Area, and several wilderness and primitive areas are located in or adjacent to the basin. Many tourists and recreationists travel to or through the basin while enroute to these well-known attractions. A major part of the recreation activity occurs on public lands.

There are four state parks covering an area of 55,500 acres of land and water. Hot Springs State Park at Thermopolis contains one of the world's largest mineral springs and one of the few remaining buffalo herds. Sinks Canyon State Park is located in a very scenic area on the Middle Popo Agie River. Boysen and Buffalo Bill State Parks surround large reservoirs, each containing several thousand surface acres. Dude ranches, resorts, historic places, and municipal parks also provide recreation opportunities.

Recreation needs in the basin are a function of both local and national forces. However, the latter will become increasingly more important in the future. Along with increases in population, vacation and leisure time, and per capita income, there will be associated increases in recreational pursuits. The Wind-Bighorn-Clarks Fork Basin with its large areas of public lands, will have to absorb some of this pressure.

Estimated levels of recreation activity for the basin are shown in table V-3. Total use is projected to increase from 4,870,400 visitor days in 1970 to 11,420,400 visitor days in 2020, an increase of 135 percent. This change will be a function of increases in both resident and nonresident populations as well as changes in participation rates for each. The projections of use may be low because of population increases associated with coal mining east of the basin in Wyoming and Montana.

In this report, all levels of recreation activity are expressed in visitor-days. One visitor-day equals 12 hours of recreation activity. For example, one visitor-day of picnicking represents six persons having one 2-hour picnic or one person having six 2-hour picnics. One person camping for a 24-hour period would account for two visitor-days. Each visitor-day may represent more than one recreational experience. More than half of the total annual use occurs during peak periods associated with weekends and holidays.

The numbers listed in table V-3 are for the basin as a whole. They indicate a surplus of facilities over expected use for all the activities listed except camping. However, the quality of recreational experiences is not expressed by these numbers. For example, the total usable water surface in the basin is more than enough for the number of boats used in the basin. The capacity of existing docking and ramp facilities well exceeds the reported and expected use. Nevertheless, a 1967 boating survey in Wyoming revealed that both resident and nonresident boaters felt that more and improved ramp facilities were needed. There are indications that locally available water surfaces suitable for water skiing are in short supply.

Camping facilities in the basin are not now adequate for peak period demands although some campgrounds are not completely filled even during peak periods. The need is for additional facilities in high use locations. If the present supply of individual camping spaces is compared

Table V-3--Present and projected use and supply of recreation activities

Activity	Current	1985	2000	2020
	thousand visitor days			
Boating				
Use	70.0	98.0	118.0	148.0
Supply	206.0	206.0	206.0	206.0
Outdoor swimming				
Use	77.7	113.5	135.0	172.7
Supply	135.0	135.0	135.0	135.0
Camping				
Use	1,797.0	2,424.0	2,932.2	3,741.1
Supply	3,338.0	3,338.0	3,338.0	3,338.0
Picnicking				
Use	108.7	134.5	161.2	202.3
Supply	218.1	218.1	218.1	218.1
Sightseeing				
Use	2,481.5	3,822.1	4,932.0	6,348.8
Supply	34,433.0	34,433.0	34,433.0	34,433.0
Snow skiing				
Use	52.7	105.7	125.9	155.9
Supply	136.0	136.0	136.0	136.0
Hiking				
Use	282.8	425.0	514.0	651.0
Supply				
Total use	4,870.4	7,122.9	8,918.3	11,420.4

to the estimated peak period use, the additional camping spaces needed are as follows:

Time	Additional camp spaces needed
Present	210
1985	700
2000	1,040
2020	1,780

However, providing adequate camping spaces for the estimated peak period demand with conventional facilities is likely to be economically inefficient because of the cost of managing, policing, and maintaining them during slack periods of low revenue. This is probably the principal reason that some existing facilities are less than adequate and a few are overtaxed to the point of damage. The disparity between use and supply can be reduced by modifying either use or supply. New approaches are needed to redistribute the timing and nature of recreation uses and to provide adequate, attractive facilities at the least cost with minimum adverse effects on the environment. One example might be to provide more special use facilities and reduce the dual use of camping facilities. Changes are needed for both public and private facilities.

Snowmobiling is becoming a very popular outdoor recreation activity in the basin. In 1972, there were 1,930 snowmobiles registered in the study area as compared to 7,537 for the entire state. However, it was estimated that 12,000 to 15,000 snowmobiles are owned by Wyoming residents. No attempt was made to measure the total visitor-days of use associated with this activity.

As the use and development of recreation areas increase, there will be a greater need to control the location and distribution of facilities. This may require city and county zoning laws, additional information concerning use-density relationships, and improved design and maintenance of recreation facilities.

FISH AND WILDLIFE HABITAT NEEDS

There are 4,254 miles of stream and 61,340 surface acres of natural lakes, reservoirs, and farm ponds that provide sport fishing opportunities in the basin. Annual fisherman-days of use and capacity in 1971 are shown in table V-4.

The greatest fishing pressure in terms of fisherman-days occurs on lowland lakes and reservoirs. Most of this use is on large reservoirs including Boysen Reservoir, Buffalo Bill Reservoir, Bighorn Lake (Yellowtail Reservoir), and Ocean Lake. Part of the reason for this is that these lakes are open for some kind of fishing during the whole year.

Alpine lakes and reservoirs and streams also provide many fisherman-days of use. The nonresident and tourist anglers (5-day license holders) tend to fish in the streams more than lakes and reservoirs, while the opposite is true with many resident fishermen. Twenty-one percent of the ice fishing in Wyoming takes place in the Wind River portion of the basin.

Table V-4--Estimated fishing pressure and capacity of streams, lakes, reservoirs, and farm ponds, 1971

Item	Amount		Use	Capacity
	Area	Length		
	--acres--	--miles--	--annual fisherman-days--	
Streams		4,254	26,655	80,757
Alpine lakes and reservoirs	9,683		20,384	89,604
Lowland lakes and reservoirs	51,526		81,289	313,548
Farm ponds	132		2,870	2,870
Total	61,340	4,254	130,198	486,779

Source: Wyoming Game and Fish Commission

Farm ponds currently provide only a small part of the fishing resource, and they are generally used to their practical maximum capacity. Streams, lowland lakes and reservoirs, and alpine lakes and reservoirs could support 3.0, 3.8, and 4.4 times the present fishing pressure respectively without changing the existing management policies. These capacity levels cannot be maintained if there is a degradation in quantity and quality of the fisheries.

The number of hunters, hunter-days (including successful and unsuccessful hunters) and estimated harvest in 1969 for the basin are shown in table V-5. Participation in hunting is influenced in part by licensing requirements. For some species, licenses are issued on a quota basis. The nonresident hunting and fishing license entitles the holder to take an antlered elk and to fish. For most of the sportsmen in this category, elk hunting is the primary intent, and fishing rights are generally incidental or of secondary importance.

The demand for hunting opportunities for both residents and nonresidents is expected to increase substantially. Population increases and changes in socio-economic characteristics will greatly influence the amount of hunting opportunities desired.

Table V-5--Hunters, hunter-days, and harvest of game, 1969

Type of game	Hunters	Hunter-days	Harvest
	number		
Big game:			
Deer	23,210	72,898	15,991
Elk	12,969	50,347	4,623
Moose	81	261	70
Black bear	860	4,804	103
Antelope	3,146	6,288	3,094
Bighorn sheep	161	1,107	47
Total	40,427	135,705	23,928
Upland and small game: 1/			
Pheasant	7,480	25,519	25,767
Chukar partridge	4,071	14,376	14,052
Hungarian partridge	1,677	6,378	3,762
Sage grouse	2,976	8,170	13,095
Blue and ruffed grouse	209	523	410
Cottontail rabbit	4,356	22,745	41,147
Total	20,769	77,711	98,233

1/ Bobwhite quail are also hunted, but information is not available.

Source: Wyoming Game and Fish Commission

The capacity to increase the supply of game species is dependent upon the quantity and quality of habitat available. Acquisition and management of additional habitat areas as well as better protection of existing habitat will be needed in the preservation of present populations and provision for expanding the future carrying capacity.

NEEDS FOR WATER QUALITY CONTROL

At 620 to 695 mg/l the dissolved solids content of the water leaving Wyoming in the Bighorn River is approaching the recommended upper limit of basic domestic and livestock use. There is a need to institute programs which will prevent any further degradation of water quality and then enhance water quality where this is feasible as by treating feedlot wastes, reducing erosion, and other actions.

RURAL AREA ELECTRIC POWER NEEDS

The directory of the Tri-State Generation and Transmission Association

lists six rural electric cooperatives serving rural areas in the Wyoming portion of this river basin. In 1970 they supplied about 380,000,000 kilowatt-hours (KWH) of electric power. The Power Requirements Office of the Rural Electrification Administration estimates that power needs of these six rural electric cooperatives will expand as follows:

Forecast year	1980	2000	2020
Kilowatt-hours needed	546,000,000	1,500,000,000	3,100,000,000

These are forecasts based on a continuation of past trends and may be significantly over or under estimated. It is quite clear that these increases in electric power generation cannot be achieved with present technology without seriously degrading the quality of air, land, and water in the basin.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Programs are available through the U. S. Department of Agriculture and the State of Wyoming to help solve many of the problems and meet many of the needs of this river basin. This chapter lists some administering agencies and briefly describes their current programs. Some existing projects are also briefly described.

SOIL CONSERVATION SERVICE

The Soil Conservation Service (SCS) assists conservation districts in giving technical assistance to individuals, groups, organizations, towns, cities, counties, and state governments in reducing costly waste of land and water resources and in using them according to their capabilities. This is accomplished through unified planning that combines all the technologies, considers all the resources, and recognizes the human interests that apply to each area of land and water use. The major SCS programs available to residents of the basin are described below.

Assistance to landowners

The SCS has a basic continuing program of providing technical assistance in the conservation of land, water, and related resources as requested by landowners and state and local governments which have planning authority. Conservation districts provide local direction, leadership, and coordination of this program.

There are about 2,400 landowners and operators who have signed agreements to cooperate with conservation districts in the basin. They own or lease about 4,400,000 acres of land including about 800,000 acres of federal land. Nearly 2,000 conservation plans have been developed for about 3,300,000 acres of land. The following are some of the conservation practices on the land in 1971.

About 250 of the 2,230 miles of irrigation canals and laterals have been lined to reduce water losses. About 1,489,000 acres of rangeland have planned grazing systems. Over 1,200 miles of drains have been installed, and nearly 160,000 acres of cropland have been leveled or smoothed for better water management. About 59 miles of streambank have been stabilized. Eighty-two miles of pipe for livestock water, 62,000 water control structures, 143 sprinkler systems, 200 other irrigation system improvements, 282 grade stabilization structures for erosion control, 12,000 miles of fencing for better range use, 250,000 acres of brush control for better vegetation, and 240,000 acres of conservation rotation cropping systems to improve the soil are examples of the conservation work planned and applied to 1971. About 86 different reportable types of conservation practices have been reported. Five of these involve about 35,000 acres of land which have been converted to less intensive uses to protect the soil and enhance wildlife habitat and recreation uses.

Soil surveys and water supply forecasting are supporting activities in planning the wise use of land and water. Detailed soil surveys have been completed for about 1,900,000 acres in the basin, and generalized soils maps are available for the entire basin. This information can be obtained by landowners from the local SCS offices. Water supply forecasts are published monthly from February through May each year for the nine major water source areas in the basin. Some information from these forecasts is published in local newspapers. More detailed information can be obtained from local SCS offices. Interested individuals may request to have their names placed on the regular mailing list and receive a copy of each monthly forecast.

Watershed protection and flood prevention projects

The SCS provides technical and cost-sharing assistance in planning, designing, and installing land treatment measures and structural works of improvement in small watershed projects. These projects are designed to reduce floodwater, erosion, and sediment damages and to promote other water and related land management and development practices as desired by the local sponsors of these projects. Applications for assistance are submitted to the Secretary of Agriculture through the Wyoming State Conservation Commission and the State Conservationist of the SCS.

There is one existing watershed project in the basin. This is the Candy Jack Watershed Flood Protection Project in and near the town of Thermopolis. About 4,000 feet of large diameter pipe have been installed to protect about 100 homes and 10 businesses on about 400 acres from frequent flooding. The Town of Thermopolis and the Hot Springs Conservation District were the sponsoring local organizations for the project.

Resource Conservation and Development Project (RC&D)

The SCS is responsible for coordination of U. S. Department of Agriculture RC&D activities and provides technical and financial assistance to locally sponsored RC&D projects. The objective is to expand socio-economic opportunities for the people of an area by assisting them in developing and carrying out plans of action for the orderly conservation, improvement, development, and wise use of their natural resources.

Applications for projects are submitted to the Secretary of Agriculture through the Wyoming State Conservation Commission and the State Conservationist of the SCS. When a project is authorized for planning assistance, a coordinator is appointed who assists local sponsors in developing a plan. This takes from 6 months to a year or more. Most projects have citizen and advisory committees for agriculture, forestry, water resources, business and industry, transportation, health, education, recreation and wildlife, and community facilities. Policies and priorities are set by a steering committee or executive council composed of the representatives from the sponsoring units of government. The

project then becomes eligible for technical and financial assistance in project measures.

At the present time an application has been approved, and a project plan is being developed for the Bighorn Basin RC&D Project for the five counties which include most of this river basin (Big Horn, Fremont, Hot Springs, Park and Washakie Counties).

FOREST SERVICE

The U. S. Forest Service provides technical assistance to the state and private owners through cooperative agreements with the State Forester. It administers national forest lands under the multiple use concept to provide forest projects, recreation, forage, and watershed protection.

Cooperative state-federal forestry programs

The U. S. Forest Service and the Wyoming State Forestry Division of the State Land Office cooperate in several programs. The Clarke-McNary Cooperative Fire Control Program in Wyoming was 15 years old on April 8, 1974. Since 1959, 18 counties, the State Game and Fish Commission, and the State Recreation Commission have made formal agreements with the State Board of Land Commissioners for improved fire protection on over seven million acres of state and private forested and nonforested watershed lands. The effect of the program is bringing basic organized fire protection to all rural lands within each participating county. However, in the basin, only Fremont and Hot Springs Counties are covered by cooperative fire control agreements.

Under the authority of the Cooperative Forest Management Act of August 25, 1950, the State of Wyoming entered this Cooperative Forest Management Program on January 5, 1962. The purpose of the program is to improve and maintain the productivity of state and private forest lands; to reduce waste in harvesting, marketing, and in the primary processing of forest products; and, by so doing, assist in increasing the income and general welfare of the people of the state. Technical forestry assistance is provided to private forest owners in forest management planning, timber sales, utilization and marketing of forest products, tree thinning, forest protection, etc. Similar service is provided to processors of primary forest products in locating raw material, operation and layout of mill and processing equipment, and otherwise promoting increased efficiency in the primary processing of forest products.

The objective of the Forest Pest Control is to protect state and private forest resource values against damage and loss caused by forest insects and diseases. This is accomplished through continuing and periodic activities to prevent, detect, evaluate, and suppress forest insect infestations and disease conditions on state and private lands. Participation in the program is carried out under the Forest Pest Control Act of August 1947.

The State Forestry Division cooperates with the Forest Service and the Soil Conservation Service in the planning and development of small watershed projects. The division is responsible for the examination and recommendation of land treatment measures on all classes of state land and private forested land. These recommended measures are for range improvements, tree planting, erosion control, etc.

Resource Conservation and Development Projects are an example of cooperation between federal, state, and county agencies, local organizations, and local people. The Forest Service and the State Forester are participating in the Bighorn Basin RC&D Project.

On July 1, 1967, the State of Wyoming entered the Title IV Tree Planting Program (Agricultural Act of 1956). The objective of the program is to bring state-owned forest land up to maximum production by appropriate reforestation methods including site preparation, direct seeding, and tree planting. Reforestation of state lands is currently proceeding at the rate of approximately 100 acres per year. At the present time this program is not funded to include this study area. Under the provisions of the Clarke-McNary Act of 1924, private landowners may obtain tree seedlings for windbreaks, shelterbelts, and forest plantings from the University of Wyoming through extension county agents.

The Wyoming State Forestry Division and the U. S. Forest Service have cooperative agreements with Big Horn, Park, and Washakie counties for land use planning, coordination, and cooperation.

National forest development and multiple use programs

Table VI-1 summarizes the land treatment and structural measures currently planned under existing programs for the national forests in the basin. The measures listed in the table are included in the following programs:

Water resource programs

Currently planned watershed management practices include 5 miles of gully control and coordination of other resource uses with watershed management. Planned measures benefiting watersheds include range revegetation and type conversion on 8,300 acres, 350 miles of range fence to protect problem areas and newly established vegetation, and reforestation and afforestation of 5,400 acres (table VI-1). In addition, thinning, release, and weeding planned primarily to benefit timber resources can have a secondary effect of increasing water quantity by reducing evapotranspiration.

Timber resource programs

Timber is an important product of the national forests, and as projections in Chapter III indicate, increasing demands are expected in the future. Timber management activities planned under existing

The SCS assists conservation districts by providing technical assistance to landowners.

A large diameter pipeline now provides flood control for the Candy Jack Watershed.

The Recreation and Tourism Committee meets to help develop the Bighorn Basin RC&D plan.

Timber harvest management is just one of the activities of the U. S. Forest Service.

U.S. FOREST SERVICE PHOTO

PLATE 25

programs include up-to-date inventories on all national forest lands; better sale preparation and administration; reduction of insect and disease losses by 50 percent; improved utilization of available timber on sale areas and from conversions and other clearings; better accessibility by constructing 1,370 miles of roads and 44 bridges; release, weeding, thinning, and pruning on 23,100 acres; reforestation and afforestation on 5,400 acres of land; reduction of fire losses; and continued research to improve genetic characteristics of trees and provide better silvicultural practices (table VI-1). Achievement of these planning goals in the next 10 to 15 years will have some effect on timber supplies in the 1980-1990 period, but most will come in 2000 to 2020 and beyond.

Range resource programs

The development and management activities planned under existing range resource programs are: complete allotment inventories and management plans for all national forest land; revegetation, plant control, and type conversion on 14,600 acres; and construction of 355 miles of range fence, 160 miles of stock distribution trails, and 250 stockwater developments.

Recreation resource programs

Most of the outstanding natural attractions and potential outdoor recreation areas are in the national forests. It is the objective of the Forest Service to develop and manage these recreation resources to meet public demand in terms of kind, quantity, and quality. Current Forest Service programs are adequate to supply projected outdoor recreation sites for most land-based activities through the year 2000. Some planned measures are 1,300 miles of trail construction and improvement, 1,370 miles of road construction and improvement mentioned previously, and 60 roadside observation sites, vista points, and scenic turnouts.

Fish and wildlife habitat resource programs

Wildlife and fish resources attract many visitors, and this use is expected to increase. The resources are considered adequate to meet current demands in spite of past reductions in the amount and quality of habitat. The Forest Service program is designed to enhance wildlife and fishery resources, restore forest quality, and mitigate losses from development and land use changes.

Measures planned for the next 10 to 15 years include about 410 miles of stream habitat improvement, lake habitat improvement on 1,160 acres, establishment and release of wildlife forage plants on 30 acres, and 3 miles of fencing to protect key wildlife areas. The watershed programs which reduce erosion and sediment will have a favorable effect on fisheries as water quality is improved or maintained.

Table VI-1--Land treatment and structural measures currently planned under existing programs for the Shoshone and Bighorn National Forests in the river basin

Item	Unit	Amount
Range revegetation - plant control and type conversion	acres	14,600
Range management - stock distribution trails	miles	160
Range management - fences	miles	355
Range management - water development	each	250
Reforestation and afforestation - planting and seeding	acres	5,400
Timber management - release, weeding, thinning, and pruning	acres	23,100
Fish habitat improvement - streams	miles	410
Fish habitat improvement - lakes	acres	1,160
Wildlife habitat management - establish forage plants and release wildlife food plants	acres	30
Wildlife habitat restoration and development - protect key areas by fencing	miles	3
Trail construction and improvement	miles	1,300
Road construction and improvement	miles	1,370
Roadside observation sites	each	10
Road, trail, and stock driveway bridges	each	44
Erosion control:		
Gullies	miles	5

Source: Developed by U.S. Forest Service from Project Work Inventory Data.

ECONOMIC RESEARCH SERVICE

The Economic Research Service conducts national and regional programs of research, planning, and technical consultation and services pertaining to economic and institutional factors and policies which relate to the use, conservation, development, management, and control of natural resources. This includes estimating the extent, geographic distribution, productivity, quality, and contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials, and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and the recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

The ASCS has administered the Rural Environmental Assistance Program or a similar program for a number of years. This program has been discontinued, but a new Rural Environmental Conservation Program is being developed to accomplish similar goals. The major purpose of these programs is to improve the quality of life for all people by helping farmers and ranchers to prevent pollution of land, water, and air and to conserve soil, water, woodland, and wildlife resources. This is done with financial assistance through the ASCS and with technical assistance of the SCS and the Forest Service.

The major types of practices encouraged are those which establish, improve, or protect the soil with a cover of trees, grasses, or legumes; provide primarily for the conservation or safe disposal of water; provide for pollution abatement or environmental enhancement; and provide protection from erosion. Emphasis is given to enduring practices and those which benefit low income farmers, community efforts, and youth and minority groups.

A farmer or rancher who desires assistance must file a request before he starts the practice for which he desires assistance. Approval is based on a decision as to the priority of the practice. Cost-sharing is based on acceptable completion and maintenance of the practice. Groups of two or more are encouraged to participate in pooling agreements. Cost-sharing rates vary by practice.

Over 886 farms participated in the REAP program in 1971. Table VI-2 gives data concerning major kinds of assistance provided during the year for the five-county area comprising most of the river basin.

FARMERS HOME ADMINISTRATION

The Farmers Home Administration provides financial assistance to individuals and organizations (private or public) and technical and management assistance. The overall objective is to strengthen family farms and rural communities. There is a Farmers Home Administration office serving every rural community in the United States.

In the broadest sense, the legislative authority for the various loan programs administered by the Farmers Home Administration is the Consolidated Farmers Home Administration Act of 1961, as amended. Authorities under the various sections of the act are very broad and include in part the following specific loan purposes: purchase, enlargement, and improvement of family-type farms; farm operating expenses, purchase of farm machinery, livestock, and equipment; construction of rural homes and farm service buildings; development of community water and waste disposal facilities, (PL-87-128, Section 306); development of recreational facilities; watershed development (PL 566, Section 8); soil and water conservation; shifts in land use; rural renewal projects; and resource conservation and development (PL-87, Section 703).

Table VI-2--Summary of REAP assistance, 1971

County	Cost-Shares	Control Competitive Shrubs	Establish Permanent Cover	Land Leveling	Reorganize Irrigation Systems
		acres	acres	acres	acres served
Big Horn	$106,087	5,850	1,830	523	12,510
Fremont	$ 70,168	375	1,650	395	9,950
Park	$ 89,074	3,500	943	411	3,885
Hot Springs	$ 18,365	5,350	275	70	412
Washakie	$ 39,925	3,540	98	124	855
Totals	$323,619	18,615	4,796	1,523	27,612

There are essentially no limitations which would restrict or prohibit extension of financial assistance to correct water and related land resource problems. Farmers Home Administration loans supplement, and in no case, compete with credit provided by other lenders.

COOPERATIVE EXTENSION SERVICE

The Extension Service is a part of the Cooperative Extension Service partnership. Federal, state, and county governments share in financing, planning, and carrying out information and educational programs. The Extension Service acts as the educational agency of the U. S. Department of Agriculture. Extension specialists and county agents cooperate with other agencies to provide local information relating to conservation programs, weed control, crop culture, animal culture, herbicides, pesticides, fertilizers, homemaking, and other types of information and assistance.

WYOMING STATE AGENCIES

Wyoming State Conservation Commission

The Wyoming State Conservation Commission assists and guides thirty-nine conservation districts throughout Wyoming in the development of conservation education programs, information programs, and total resource conservation programs to promote multiple and wise use of our natural resources in urban and rural development. Each conservation district is governed by five local citizens and provides the starting point for small watershed projects (PL-566) and resource conservation and development projects (RC&D) in the state. Conservation of our soil and water resources is improved as the districts assist in irrigation projects, mine reclamation,

soil surveys, and conservation planning for individuals, groups, and units of government.

The Wyoming State Conservation Commission is the state agency designated by the Governor to review and approve small watershed projects and RC&D projects applications and plans. The Commission sets the priorities and direction for Soil Conservation Service activities on small watershed projects. The Commission may also assist in accelerating work on these projects by employing consultants to acquire basic information for preliminary investigations of feasibility.

Wyoming Department of Agriculture

The State Department of Agriculture is assisting agriculture in Wyoming to meet the needs of the present and the future and to add to the economy of the state. Departmental programs related to land and water and related resources development are described below.

Division of Plant Industry

The Division of Plant Industry administers a Weed and Pest Program which provides funds and technical assistance to landowners. Each of the five counties in the basin is a Weed and Pest Control District. These districts participate with all agricultural groups in the control of designated weeds and pests. The division also offers technical assistance in brush control, insect control, and plant diseases, and, on a routine basis, sample fertilizers, pesticides, and seeds for label compliance.

Division of Markets

The Division of Markets furnishes technical assistance in the fields of transportation, marketing, and statistical information to assist in the development of feasible programs with regard to freight rates, agri-business, export, and import of all agricultural products. The division has the responsibility of grading and inspection of produce entering and leaving the state. The Weights and Measures Section of this division inspects and tests all commercial weighing and measuring devices in the state and checks the correct quantity and weight of products and merchandise offered for sale.

Division of State Laboratories

The Division of State Laboratories, located on the University of Wyoming campus at Laramie, furnishes the expertise and equipment necessary to analyze fertilizers, pesticides, drugs, feeds, water potability, food, or any commodity as it pertains to humans or animals.

Division of Food and Drug

The Division of Food and Drug surveys food producers and processors for compliance with minimum standards. Routine survey and sampling of food

and food products is also conducted to determine wholesomeness and compliance with label guarantees. Dairy producers and processors must also conform to established minimum requirements as set by law.

Division of Agricultural Planning and Development

The Division of Agricultural Planning and Development has a responsibility to help the development of the agricultural sector of the state's economy. This is accomplished through conducting economic and statistical studies, planning for agricultural development, and public involvement, information, and education programs. These activities are done in coordination with various agencies of local, state, and federal governments.

Wyoming Department of Economic Planning and Development

The Wyoming Department of Economic Planning and Development (DEPAD) is charged with the planning for and development of the physical and economic resources of the state. The department consists of the office of economic planning and development; administrators and councils of the division of water, industrial and mineral development; and the board of economic planning and development.

The division of water development is responsible for activities in connection with state financial assistance for water development projects. The department determines engineering and economic feasibility in order to base recommendations to the Wyoming Farm Loan Board for loan approval. Loans in an amount not to exceed $150,000 are available to court approved water districts with taxing authority, agencies of state and local government, persons, corporations, and associations in Wyoming. A majority of the shareholders must be Wyoming electors. Court approved water districts with taxing authority are eligible for funds in excess of $150,000. The annual interest rate on reservoir loans is 4 percent for a term not to exceed 40 years. Sprinkler irrigation loans are limited to a maximum term of 15 years at an annual interest rate not less than 4 percent and not greater than 8 percent to be set by the Farm Loan Board. The interest rate for loans other than reservoirs was set at 5.5 percent effective September 6, 1973. Other activities of the Division of Water Development include entering into contracts and agreements, reserving water resources, entering into water service contracts, and setting water rates for that service.

The division of industrial development is responsible for investigations and preparing plans and specifications for development in connection with any resource of the state, industry or business within the state and attracts new industry into the state. The division makes studies of soil and its uses, and makes studies to promote and protect the forest and range areas within the state.

The division of mineral development makes studies of all mineral resources, mines and mining, the exploration, development, conservation

and production of oil and gas and other minerals, and prepares state legislation pertaining to resources of the state.

The Chief of state planning is responsible for the comprehensive state plans for the physical and economic development of the state.

Wyoming State Forestry Division

The Wyoming State Forestry Division administers and manages all forested state lands, participates in cooperative state-federal forestry programs described earlier in this chapter, and provides assistance to private landowners. Major activities in the assistance to private landowners are for fire control, forest management, pest control, and tree planting. This office cooperates with federal agencies in assisting in the planning of small watershed projects and resource conservation and development project measures.

Wyoming State Engineer

The State Engineer is responsible for the supervision of the state's water resources. Unreserved water may not legally be diverted from any natural source until a permit is obtained from the State Engineer. The Board of Control, with the State Engineer as president, adjudicates water rights and provides the field supervision of water rights and uses. The State Engineer is also responsible for the coordination of state water resources planning. The Wyoming Water Planning Program has developed a Framework Water Plan. The State Engineer requested this study to assist this state organization and provide the state with more information about USDA program opportunities in the basin.

Wyoming Public Service Commission

There are three areas of water and related land resource development where the Public Service Commission has programs. They are: (1) rural, domestic, and livestock water supply, (2) municipal and industrial water supply, and (3) rural power supply. The commission is charged by law with the regulation of all utilities in the State of Wyoming including water utilities and Rural Electric Associations. Individuals, companies, or associations that intend to provide a utility, commodity, or service to the public must first obtain a certificate of public convenience and necessity from the commission. The commission does not provide financial assistance.

Wyoming Department of Environmental Quality

The Water Quality Division of this department is presently the state planning, coordination, and approval agency for water pollution controls and solid waste management programs which can receive federal assistance through the Environmental Protection Agency. The town of Lovell and the north Big Horn County community are presently developing a solid waste collection and disposal system through this program.

Wyoming Game and Fish Department

The State Game and Fish Department is authorized to enter into cooperative agreements with federal agencies, corporations, associations, individuals, and landowners for the development of state control of wildlife management and demonstration projects. Many public access areas for hunting and fishing have been established through this program. The Ocean Lake and Yellowtail Wildlife Habitat Management Units are managed by the Department through various agreements with federal land administering agencies. The Department cooperates with USDA agencies in providing technical assistance to landowners who want to improve fish and wildlife habitat.

Wyoming Recreation Commission

The Wyoming Recreation Commission administers the Boysen and Buffalo Bill State Parks in the basin. It also administers the Land and Water Conservation Fund through which financial assistance is provided to tax-based legal entities for the development of outdoor recreation areas and facilities. The commission administers state-owned historic sites, monuments, and markers. It also administers the Historical Preservation Fund and the Snowmobile Registration Act.

Special purpose districts

Districts are political subdivisions of the State of Wyoming. Several single purpose districts such as irrigation districts, drainage districts, and flood control districts may be created under state law. Others, such as conservation districts, watershed improvement districts, and water conservancy districts, can be multipurpose in nature. Each kind of district has unique powers and limits of power. Conservation districts promote the wise use of water and related land resources through the cooperative action of landowners. They secure technical assistance from the SCS or other agencies, help cooperators secure needed supplies and materials not readily available, and sometimes secure special equipment needed to apply conservation practices on the land. Watershed improvement districts are usually formed to provide local sponsorship, leadership, land rights, and funds for watershed projects.

EXISTING RECLAMATION PROJECTS

About 168,600 acres of cropland have been developed in the basin through reclamation projects. The existing projects are listed below.

Owl Creek Unit

This is a project which includes a storage dam and pumping facilities to ultimately provide supplemental water to 13,123 acres of irrigated land. Water is presently pumped from the Bighorn River to supplement the water from Owl Creek for about 3,210 acres of land in the Lucerne area. When

finally completed and sealed, Anchor Reservoir will store 17,300 acre-feet of water to assure a water supply for about 9,913 acres. In 1972, 10,921 acres were being irrigated.

Boysen Unit

The Boysen Dam is a flood control, power, and flow regulation dam for irrigation, municipal, and industrial uses. The Boysen Unit improves downstream late water supplies and provides supplemental water for upstream lands by exchange, but no irrigation development is included in the Unit. In 1972, 50,520 acres received a supplemental water supply from Boysen Reservoir.

Shoshone Project

This project is based on storage and flow control by Buffalo Bill Dam. Irrigated lands for this project extend from Cody to Kane, Wyoming, and include about 92,814 acres presently irrigated by the project. Power is generated at Buffalo Bill Dam and at Heart Mountain Power Plant.

Hanover-Bluff

This is a pumped water supply project using Bighorn River water controlled by the Boysen Dam. There are 7,301 acres presently irrigated by this project.

Riverton Reclamation Project (Now a unit of the Pick-Sloan Missouri Basin Project)

Water is diverted from the Wind River near Morton to supply about 54,281 acres of irrigated land from Pilot Butte to the Boysen Reservoir. Bull Lake storage is involved in this project. Power was generated at Pilot Butte Reservoir until 1973. A total of about 56,487 irrigable acres could be irrigated by the project.

EXISTING IRRIGATION PROJECTS DEVELOPED THROUGH THE BUREAU OF INDIAN AFFAIRS

Nearly 39,000 acres on the Wind River Indian Reservation are irrigated from projects developed through federal assistance.

EXISTING IRRIGATION PROJECTS THROUGH PRIVATE DEVELOPMENT

Although federally developed and assisted irrigation projects are extremely important to the economy and social welfare of the river basin, over 60 percent of the irrigated area or about 331,000 acres have been privately developed. Individual systems on farms and ranches comprise a noteworthy part of this development. More impressive are the group enterprise developments which have built reservoirs, canals, laterals, diversion dams, and control structures to provide water to many farms. Early developments were much assisted by the provisions of the Carey Act. These

systems are constantly being improved through private initiative, often with the assistance of the programs administered through the USDA described earlier in this chapter.

New private developments are still possible and can be assisted through state programs also described earlier in this chapter.

EXISTING PROJECT OF CORPS OF ENGINEERS

The town of Greybull is protected against frequent flooding and ice jams of the Bighorn River by about 14,000 feet of levee constructed by the Corps of Engineers. The Corps also has authority to provide regulations for existing dams in the basin to prevent or reduce flood damages.

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management administers the unreserved public lands in this basin and the nation. These lands produce wildlife and fish habitat, timber and other wood products, land and water recreation opportunities, minerals, and grazing for livestock. The Bureau has an active program of range and watershed improvement through brush control, contour terracing and furrowing, fencing, seeding, waterspreading, and building detention dams, diversions, stock water ponds, and spring developments. It also has an active program of recreation site selection, withdrawal, and development.

Public lands are classified for retention in public ownership or disposal to private individuals or other public agencies. Some lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes. Some have been transferred to the Bureau of Reclamation for project developments. Some lands are available for desert land entry to qualified individuals.

VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

The purpose of this chapter is to describe some of the physical capability of water and related land resources to support development in the basin. Specific proposals for projects and programs are described in later chapters. The reader should keep in mind that economic, legal, sociological, and political restraints and limitations are generally not considered in discussing these resource potentials. The reader should also keep in mind that the development of a resource for one purpose may reduce its potential for other purposes.

AVAILABILITY OF LAND FOR POTENTIAL DEVELOPMENT

Presently irrigated cropland

Much of the presently irrigated cropland in the basin is producing at less than its sustained yield capacity. About 80 percent of the irrigated cropland in the basin could have significantly improved production through improved management, land treatment, and water distribution systems.

About 34 percent, or 182,000 acres of the presently irrigated cropland, could have increased yield if provided a full supply of irrigation water. Most of these are haylands and pasture. If about 360,000 acre-feet of water could be brought to these lands to supplement existing water supplies for second and third growth periods, they could support an increased production of 50 to 100 percent over present yields. With improved water supply there would also be increased incentive for improved management, land treatment, and water distribution systems.

Potentially irrigable land

Data from soil surveys and reconnaissance studies of the basin indicate that large tracts of land, not presently irrigated, are suitable for irrigation. These potentially irrigable lands have suitable soils and land slopes for irrigated agriculture. Many of these tracts are adjacent to lands which are presently irrigated. A large portion of these lands are owned by the federal government, but other areas are owned by state and private interests. Figure II-7 is a map showing both presently irrigated and potentially irrigable lands. Table VII-1 lists the estimated areas of irrigable land in each subbasin and estimated water requirements for full irrigation at 50 percent project irrigation efficiency.

Potential on range and dry pastureland

If all private and state range and dry pastureland were to receive improved management and treatment where needed, they could produce an estimated additional 369,000 animal unit months (a.u.m.) of roughage feed for domestic livestock and grazing wildlife. This corresponds to an increase of an average of 0.13 a.u.m. per acre on the 2,733,700 acres of this land needing improved management and treatment.

Table VII-1--Potentially irrigable lands and estimated irrigation requirements by subbasin in Wyoming

Subbasin name	Irrigable areas	Net field irrigation water demand 1/	Projected irrigation water requirement 2/
	----acres--	---inches----	-1,000 acre-feet-
Wind River	181,600	23	696
Bighorn River	642,800	25	2,678
Clarks Fork	41,600	24	166
Little Bighorn River	9,600	20	32
Total	875,600	24.5	3,572

1/ Estimated average for all crops and associated new vegetation in each subbasin.

2/ Estimated 50 percent irrigation project efficiency.

POTENTIAL SURFACE WATER DEVELOPMENT

Estimated water savings through increased irrigation efficiencies

About 66 percent or 356,830 acres of the presently irrigated cropland in the basin benefit from an abundant basic water supply. Some of these lands fail to receive a full irrigation supply because of inefficiencies in the transportation, management, and application of irrigation water. If project irrigation efficiencies on these lands were increased 10 percent, about 230,000 acre-feet less water would be diverted for irrigation each year, irrigated lands would be more evenly irrigated, increased production would result, and instream water quality would be enhanced. This does not represent a net savings of water, however, since much of the presently diverted water returns to the natural streams as irrigation tailwater or as ground-water return flow.

The potential for saving water through increased efficiencies is not so good in areas where the basic streamflow is less than enough to supply a full irrigation supply annually. Some of the irrigated lands in the basin do not receive even one complete irrigation in dry years. Increased efficiencies on these lands would result in increased production, improved water quality, and better land use. However, one of the main incentives to increase water use efficiency in these areas is to use the water on additional adjacent land, and the net result would probably be a reduction of water downstream.

Estimated water savings potential in phreatophyte areas

There are an estimated 198,400 acres of phreatophytes in the basin. These include cottonwood trees, greasewood, salt cedar, tules, salt grasses, willows, and other species. They use about 346,500 acre-feet of water each year. About 80 percent of this area is riparian vegetation along natural streams. The remaining 20 percent of the area is associated with agricultural irrigation development. Any reduction in consumptive uses by these phreatophytes should result in a net water savings of nearly the same amount.

If a 25 percent reduction in 20 percent of the area and 10 percent reduction in 80 percent of the area could be achieved, this would be a savings of about 45,000 acre-feet per year. These savings could conceivably be achieved through chemical and mechanical removal of plants, through improved agricultural water management resulting in less water flow to those phreatophytes associated with agriculture, installation of new and improved drainage systems to lower water tables, and other practices. Any attempt at phreatophyte reduction should be carefully evaluated with regard to effects on fish and wildlife habitat.

Potential impoundments

Even in the most water-short areas, water could be stored during high spring flows and short summer floods to provide supplemental irrigation water to presently irrigated lands. The mainstreams of the Wind River, Bighorn River, Clarks Fork, Shoshone River, and several of their major tributaries are water-rich areas which supply most of the water flowing from the Wyoming portion of the basin. According to interstate compact allocations, about 2,400,000 acre-feet or more might be stored and used in Wyoming.

A list of possible reservoir sites is given in table VII-2. Locations are shown on the map of figure VII-1. A large number of sites are listed in the table and shown on the map. They represent physical locations where between 200 and 25,000 acre-feet of water might be stored in a topographically possible site. However, there are several reasons why this list is deceptive. A large number of these sites are unfavorable from a geologic point of view. Suitable soils for fill materials are not readily available at many sites. Many of the sites are so small they would solve only a small part of the water shortage problem. Others are in locations where the storable water supply is very limited. Some sites require large dams to store the expected amounts of water. For these reasons the actual potential for new storage sites is very limited. Land rights are not considered to be a problem except as sites conflict with forest and wilderness area uses.

Potential for intrabasin transfer

If all storable water in water-short areas were stored, these areas would still require about 174,600 acre-feet more water each year for a

Table VII-2--Possible reservoir sites

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Primitive area 4/														
Grave Lake	14ela-4	36		36N	104W	2		4,500		200	22,000	4.89	I	6
Gill Park	14ela-2	44	6,780	32N	102W	28	(19) + (20)sq.mi.	710		300			I	1 + 6
Bills Park	14ela-2	45		32N	102W	32, 33			Unsurveyed					
Upper Cloud Creek	14e4-6	122	1,182	51N	86W	29	42	920	22	300			I	5
Middle Cloud Creek	14e4-6	123	1,183	51N	86W	29	30	440	15	380			I	5
Absaroka Wilderness 4/														
	14e6-1	154		47N	107W								I	
	14e6-1	153		46N	107W								I	
	14e6-1	152		45N	108W								I	
Forests														
	14c-3	170											I-R	
	14c-3	171											I-R	
	14c-3	172											I-R	
	14c-1	173											I-R	
	14c-1	174											I-R	
	14c-3	175											I-R	
	14c-5	176											I-R Power	
	14c-5	177											I-R	
	14c-3	168											I-R	
	14c-3	169											I-R	
	14e4-6	125		50N	87W								I-R	
	14e5-1	134		46N	103W								I-R	
	14el-4	10		43N	105W								I-R	
	14el-2	8		43N	106W								I-R	
Hough Res.	14el-la	5		43N	106W	3	164 sq.mi.	30,000			600,000	20.00	I-R	6
Stoney Point	14el-la	2		42N	108W	25	230 sq.mi.	220,000	200	900	1,640,000	7.45	I-R	6
Torrey Lake	14el-3	6		41N	106W	34	56 sq.mi.	33,000	50	3,180	500,000	15.15	I-R	6
West Tensleep Lake	14e4-4	115	6,307	50N	86W	33		1,176		500			I-R	5
Tensleep Meadows	14e4-4	116	4,557	48N	86W	5		12,353		450			I-R	5
Tensleep Meadows	14e4-4	117	1,329	48N	86W	6		13,488		45			I-R	5
Pete's Lake	14ela-2	46	5,384 6,781	32N	101W	18		762		300	11,700	15.35	I-R	1
Middle Popo Townsend	14ela-2	47	4,555	32N	101W	26							I-R	1
Louis Lake	14ela-1	48	4,063	30N	101W	1	7½ sq.mi.	8,014		240			I-R Power	2
Porcupine Creek	14e-28	167	2,016	56N	92W	12		14,661	120				I-R	5
	14e7-2	181		57N	87W								I-R	
Willett Co.	14e-22	146	4,721	53N	88W	21		869		400			I-R	5
Moraine Creek #1	14e-22	145	6,848	53N	88W	22		1,151		500+			I-R	5
Shell Lake	14e-22	144	4,595	52N	87W	17		530		350			I-R	5
Medow	14e4-6	126	1,181	51N	88W	3		285	13.5	610			I-R	5
Medicine Lodge	14e4-6	127	1,185	51N	88W	11	100	2,248		500 + 450			I-R	5
Paintrock	14e4-6	128	1,180	51N	88W	13	77	1,296		1,400			I-R	5
	14e4-6	121		51N	87W								I-R	

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Solitude	14e4-6	124	1,186	51N	87W	36	155	8,573		580			I-R	5
Private														
Brooks Lake	14el-1	1		44N	110W	25	12 sq.mi.	9,719	30		32,000	3.29	I-R	6
LeClair														
Warm Springs	14el-3	3		42N	109W	22		3,000	80				I-R	6
Warm Springs Cr.	14el-3	4		42N	108W	34		5,000						
								16,000					I-R	
North Fork	14el-3	7		41N	105W			60,000			5,000,000	83.333	I-R-F	6 + 2
	14el-2	9		7N	6W								I-R-F	
Wind River EF #2	14el-4	11		8N	5W			41,040		739			I-R-F	4
Wind River EF #1	14el-4	12		6N	6W			122,560		2,006			I-R-F-S	4
	14el-5	13		5N	5W								I-R-F-S	
Mud Lake #1	14el-6	14		4N	6W			26,208		200			I-R	4
Dinwoody Lake	14el-6	15		5N	5W			28,382		2,000			I-R	4
Dinwoody Lake	14el-6	16		5N	5W			130,620		1,900			I-R-F-S	4
Dinwoody Lake	14el-6	17		5N	5W								I-R-F-S	
Crow Creek #1	14el-5	18		7N	4W			36,312		1,373			I-R-F-S	4
Wind River #1	14el-6	19		4N	3W			195,776		4,280			I-R-F-S	4
Bull Lake Cr. #2	14el-7	20		2N	5W			20,352		840			I-R	4
Bull Lake Cr. #1	14el-7	21		2N	4W			75,740		2,240			I-R	4
Wind River #5	14el-7	22		3N	2W			40,629		2,200			I-R-F-S	4
	14el-8	23		4N	2W								I-R	
	14el-8	24		6N	3W								I-R	
	14el-8	25		6N	3W								I-R	
	14el-8	26		6N	3W								I-R	
Dry Creek	14el-8	27		5N	2W			22,508		3,640			I-R-F	4
Wind River #4	14el-8	28		3N	1W			62,650		2,960			I-R-F-S	4
Wind River #6	14el-9	29		3N	1E			70,494		4,540			I-R-F-S	4
	14el-10	30		3N	1E								I-R-F-S	
	14ela-4a	31		2N	3W								I-R	
Sage SF Creek #1	14ela-4a	32		2N	2W			35,630		1,600			I-R	4
Sage Creek #1	14ela-4a	33		1N	1W			14,456		1,720			I-R-F	4
Little River SF #2	14ela-4	34		1S	4W			56,430		1,003			I-R	4
	14ela-4	35		1N	3W								I-R-F	
Grave Lake	14ela-4	36		33N	104W	2		4,500		200	22,000	4.89	I-R	6
Little W. River SF #1	14ela-4	37		1S	3W			17,100		1,056			I-R	4
Little W. River	14ela-3	38		1N	1E			55,080		3,920			I-R-F	4
Sharp Nose Draw #1	14ela-3	39		1S	2E			2,380		1,480			I-R	4
Sharp Nose Draw #2	14ela-3	40		1S	2E			15,336		1,520			I-R	4
	14ela-2a	41		33N	101W								I-R	
Surrell Cr. #1	14ela-2a	42		2S	1W			16,688		840			I-R	4
Popo Agie River #2	14ela-1	43		2S	1E			38,781		1,880			I-R-F	4
Onion Flat	14ela-1	49		32N	99W								I-R	
	14ela-1	50		32N	99W	25		9,000		1,800	300,000	33.33	I-R	2
	14ela-1	51		33N	99W								I-R-F	

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Popo Agie River#1	14ela-1	52		2S	2E			102,336		4,200			I-R-F	4
	14ela-5	53		29N	97W								I-R	
	14ela-5	54		30N	97W								I-R	
	14ela-5	55		30N	97W								I-R	
Smith & Bringolf	14ela-5	56	2,815	32N	96W	16		426		200			I-R-F	1
Beaver Creek	14ela-6	57		2S	4E			27,324		4,200			I-R-F	4
	14el-9	58		2N	2E								I-R-F-S	
Loma Coyote	14e2-1	59	6,772	32N	91W	25							I-R	
Dry Coyote	14e2-1	60	6,765	32N	91W	24		256	46				I-R	5
	14e2-2	61		33N	94W								I-R	
Muskrat Conant	14e2-3	62	2,786	36N	95W	30		2,039					I-R	5
King Gorm Res.	14e2-3	63	1,974	37N	94W	36	290	5,390		2,400			I-R	5
	14e2-1	64	3,418	37N	93W	30		733		600			I-R	5
Queen Thyra	14e2-1	65	1,973	37N	93W	19		1,235					I-R	5
Teapot Gulch#1	14e-4	66		5N	1E			5,022		1,180			I-R	4
Fivemile Cr. #2	14e-4	67		5N	1E			7,776		1,180			I-R	4
Fivemile Cr. #1	14e-4	68		4N	1E			2,100		1,200			I-R-F	4
	14el-9	69		3N	5E								I	
Sagwup Draw #1	14e-5	70		7N	1W			17,157		920			I-R	4
Muddy Creek #1	14e-5	71		6N	1E			57,344		2,580			I-R	4
Shotgun Cr. #1	14e-5	72		6N	1E			7,600		1,180			I-R	4
Blue Draw	14e-5	73		6N	2E			19,968		1,320			I-R	4
Sheep Creek WF #1	14e-5	74		6N	2E			29,128		1,140			I-R	4
Golden Dome #1	14e3-4	75	3,998	40N	93W	35		432		500			I-R-S	5
Golden Dome #2	14e3-4	76	3,999	39N	92W	8		361		480			I-R-S	5
Cottonwood #1	14e-6	77		4N	5E			972		1,240			Sed	4
Cottonwood #2	14e-6	78		5N	5E			21,178		2,680			Sed	4
	14e-7	79		42N	94W								I-R	
	14e3-2	80		39N	88W								I-F	
Snyder Cr. Detention	14e3-2	81	7,133	39N	90W	13	6,079	347					I-F	5
Okie	14e3-2	82	34	39N	90W	34		217					I-F	5
Waterworks #3	14e3-2	83	6,516	38N	90W	4		211 -		1,200			I-F	5
Owl Creek S. Fork Trib.	14e-10b	84	67	43N	95W	1		3,200					I-F	5
Dempsey	14e-10b	85	2,094	44N	94W	31		1,070					I-F	5
Owl Creek SF #1	14e-8	86		8N	3W			22,680		949			I	4
Owl Creek SF #2	14e-8a	87		8N	1E			20,088		1,540			I-R	4
	14e-8a	88		9N	2E								I-R-F	
Owl Creek "Basin"	14e-8a	89	2,095	43N	100W	13		5,231	14.1	2,700			I-F	5
Mt. View	14e-8a	90	4,138	44N	98W	35		5,832	20	3,000			I-R-F	5
	14e-9	91		8N	3E								I-R	
	14e-9	92		8N	4E								I-R	
	14e-14	93		44N	98W	10							I-R-F	
	14e-14	94		44N	98W	4							I	
Little Buffalo	14e-15	95	1,334	47N	99W	4		51,197					I-R	5
Buffalo Creek	14e-15	96	1,753	47N	99W	19		145,000					I-R	5
	14e-15	97		47N	98W								I-R	
Gooseberry Cr.	14e-15	98	1,959	47N	101W	36		42,505		1,300			I	5
	14e-15	99		47N	98W								I	
[illegible]ers	[illegible]-15	[illegible]00	[illegible],604	[illegible]7N	[illegible]	[illegible]		14,[illegible]		1,[illegible]00			I	5

Table VII-2--Possible reservoir sites (continued)

Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Sunnyside	14e-15	101	1,755	46N	95W	1		522	18	2,000			I-R-F	5
	14e-15	102		47N	94W	31							I-R-F	
Fruitland #2	14e-12a	103	2,936	46N	91W	29		5,318		2,000			I-R	5
Fruitland #1	14e-12a	104	2,935	46N	92W	25		7,245					I-R-F	5
	14e-12a	105		45N	92W								I-R-F	
Fifteen Mile Cr.	14e-19	106	1,337	49N	98W	27		46,081					I-R	5
Wilson #1	14e-17b	107	1,012	47N	92W	26		386					F	5
Wilson #2	14e-17b	108	1,013	47N	92W	23		379					F	5
	14e4-2	109	3,285	43N	88W	17		231		600			I	5
	14e4-1	110		44N	88W								I-F	
	14e4-1	111		42N	88W								I	
	14e4-1	112		43N	88W	35							I-F	
	14e4-1	113		43N	87W								I-F	
	14e4-1	114		43N	87W								I-R-F	
	14e4-4	118		47N	87W								R	
	14e4-5	119		49N	87W								I-R	
	14e4-5	120		48N	89W								I-R-F	
	14e4-6	129		50N	90W								I-R-F	
Thayer Res. #1	14e5-2	130	4,154	48N	104W	14		639		700			I	5
	14e5-1	131		48N	102W								I-R-F	
	14e5-1	132		48N	102W								I-R-F	
	14e5-1	133		47N	103W								I-R	
	14e5-3	135		48N	103W								I-R	
Bawhide Creek	14e5-3	136	1,859	48N	102W	2		34,738					I-R	5
Lake McKinney #2	14e5-4	137	5,389	51N	95W	2		202					I	5
Alpha Sandstone Reservoir	14e5-4	138	3,569	51N	95W	29		579		400			I	5
Sage Cr. Coulder Wiley	14e-25	139	4,149	51N	100W	7		2,057					I	5
Oregon Basin	14e-25	140	242	52N	100W	27	5,106	382,950		150			I-R-S	5
Lithomsen	14e-25	141	4,039	52N	100W	26		1,960					I	5
Thomsen	14e-25	142	3,919	52N	100W	26		1,011					I	5
	14e-26	143		53N	96W								I	
Moberly-Stoddard Divert fr. Trapper	14e-23	147	6,768	53N	91W	34		248		500			I	5
	14e-23	148		54N	91W								I	
	14e-23	149		52N	92W								I	
Bench Canal	14e5-4	150	7,153	52N	95W	18		299		800			I	5
	14e-24a	151	2,262	55N	93W	31	100	644					I	5
Sulphur Creek	14e6-3	155	5,088	52N	102W	11, 12 13,14,15		18,480		900			I	5
Cody Canal	14e6-3	156	5,089	52N	101W	5 & 6		1,212					I	5
Beck Lake	14e6-3	157	5,090	52N	101W	5 & 6		995					I	5
Goff	14e6-6	158	3,651	54N	103W	26		663		130			I	5

Table VII-2--Possible reservoir sites (continued)

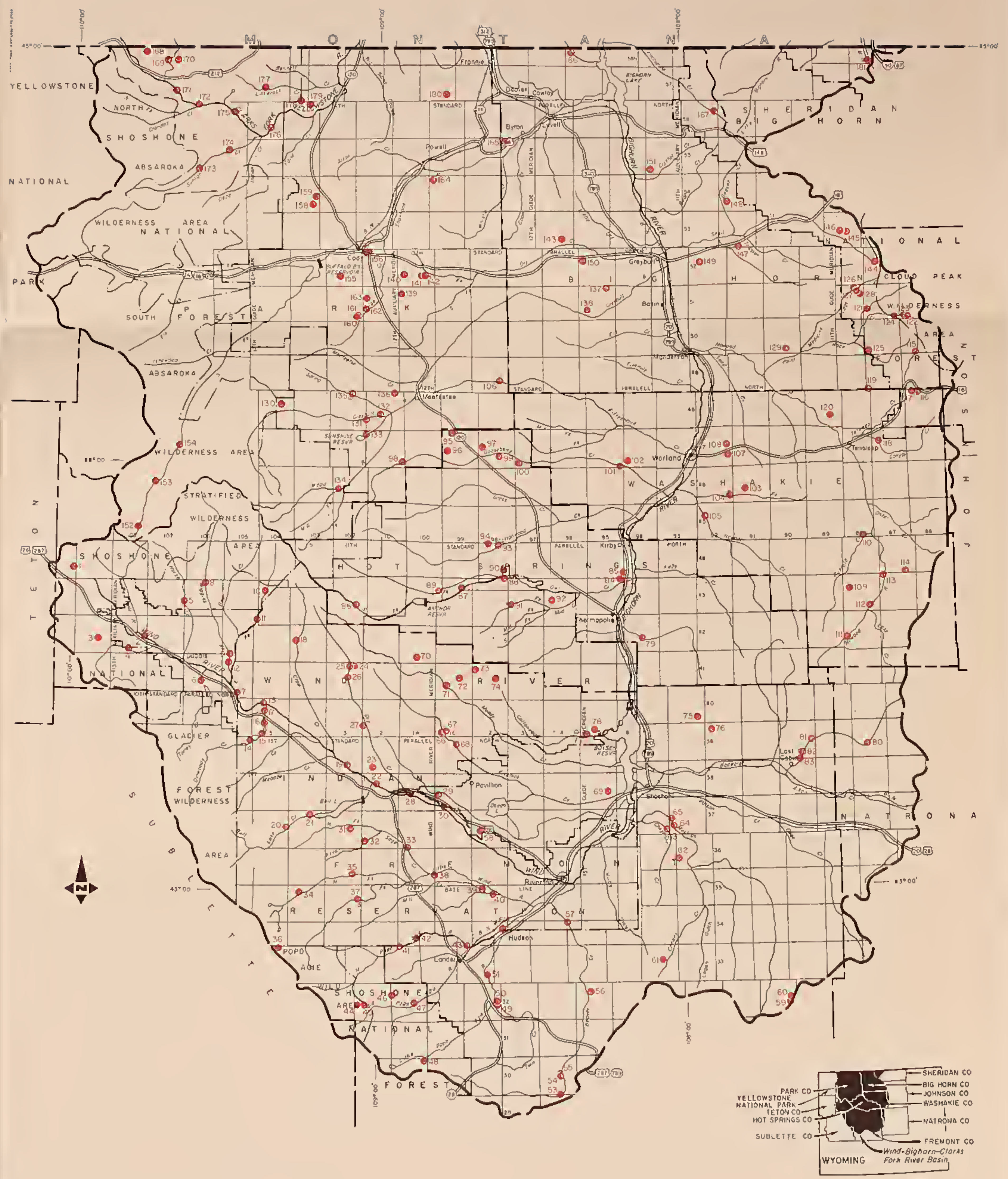
Name	Watershed Number	Reservoir map index number	State permit number	Location: Township	Location: Range	Location: Section	Drainage area acres	Estimated storage capacity (ac. ft.)	Estimated reservoir water depth (feet)	Estimated top length of embankment (feet)	Estimated embankment volume (cu.yd.)	Embankment to storage ratio 1/ (cu. yd.) (ac. ft.)	Estimated project purposes uses 2/	Data source number 3/
Skull Creek	14e-4	159	2,635	54N	103W	24		641	17.2	200			I	5
Melvina Lake	14e6-3	160	4,148	51N	102W	36		937	20	1,000			I-R	5
Melvina Lake	14e6-3	161	2,929	51N	102W	25 + 36		936					I	5
	14e6-3	162		51N	101W								I-R	
Sage Creek	14e6-3	163	2,456	51N	101W	18		1,082					I-R	
	14e6-5	164		54N	99W								I	
	14e6-6	165		55W	97W								I-F	
	14e-27	166		58N	95W								I-R	
	14c-5	179		56N	101W								I	
	14c-4a	180		57N	97W								I-S	

1/ A comparative figure derived from dividing the estimated earth fill in cubic yards by the estimated water storage capacity in acre-feet.

2/ I - irrigation, F - flood protection, R - recreation--fishing, hunting, and boating, S - water supply--industrial, municipal, and domestic. Sed - sedimentation.

3/ Source: 1 - Soil Conservation Service, 2 - Bureau of Reclamation, 3 - Corps of Engineers, 4 - Bureau of Indian Affairs, 5 - Wyoming State Engineer, 6 - Report of Water Resources on the Wind River Basin to Wyoming Natural Resource Board by Bishop & Spurlock 1962.

4/ Sites identified in Wilderness and Primitive Areas are physical possibilities only; approved for construction would require special amendments to the Wilderness Acts.



LOCATION MAP

LEGEND

12 ● Possible Reservoir Sites

SEE TEXT FOR LISTING OF INDIVIDUAL RESERVOIR SITES

FIGURE VII-1

POSSIBLE RESERVOIR SITES

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

10 0 10 20 MILES

SCALE 1:1,000,000

ALBERS EQUAL AREA PROJECTION

M7-E-22780C-N

full irrigation supply. If this shortage is to be reduced, new water sources must be developed. One source might be transfer of surface water from the larger streams in the basin. It would be physically possible to build canals and aqueducts from the Upper Wind River to provide irrigation water to most of the presently irrigated lands in both the Wind River and Bighorn River subbasins. Some of the irrigable land in the basin could also be supplied this way. Gravity flow sprinkler systems could be supplied from the main tranportation system. However, this kind of system would be very expensive and probably not economically feasible. Uncertainty with regard to appropriated versus reserved water rights also restrains development of transfers at this time.

Probably more feasible is the potential for developing systems to pump water from the Bighorn River or existing canals. However, pumping and installation costs rapidly increase as distances, pumping heads, and amounts of water increase so that it is not likely that very large scale developments of this type are economically feasible. Most of this development will probably occur through local initiative.

Some projects for development of new lands through storage and transfer of water within the basin have been proposed by the Bureau of Reclamation and are discussed in more detail in chapter IX of this report. More information can be obtained from the Bureau of Reclamation.

POTENTIAL GROUND-WATER DEVELOPMENTS

Ground water in amounts up to 450 gallons per minute (g.p.m.) from depths of less than 100 feet can be developed in valley alluvium along major drainages in the basin. However, the potential for large scale water development from valley alluvium is limited because of thin aquifers and the possibility of depleting surface flows in associated streams.

Supplies of up to 25 g.p.m. may usually be obtained within depths less than 600 feet on the basin floor in bedrock formations of the Tertiary Age. Steeply inclined older formations outcrop around the margin of the basin floor. Aquifers in these formations may yield sufficient water with artesian pressure for irrigation use. Depths to these aquifers vary widely as does the quantity and quality of water obtained from them. The potential for large producing wells of this type is restricted to a narrow band along the margin of the basin floor, and careful site selection is required.

The potential for artificial recharge of aquifers is very limited in the basin. If new lands are developed on the benches in the midwestern portion of the Bighorn River Subbasin, a shallow body of ground water will probably form in gravel deposits which might provide potential for new wells.

POTENTIAL FOR CHANNEL IMPROVEMENTS AND LEVEES

There is potential for channel improvement, streambank protection,

and levee construction to reduce flood damage and streambank erosion on many of the streams and rivers in the basin. However, in practice the installation of these measures is generally restricted to short reaches to protect roads, railroads, towns, bridges, irrigation diversion structures, and cropland.

POTENTIAL FOR WATER TABLE CONTROL

The most suitable method of obtaining water table control is to combine improved irrigation water management and irrigation systems with improved drainage systems. Table VII-3 lists the areas considered to be wetlands in various portions of the basin and their potential for improved water level control.

Of the 97,800 acres that have wet and saline soils, water table control can be improved through improved agricultural water management and irrigation systems improvement for 82,160 acres. This same area would also benefit from improved drainage systems, and 32,170 acres of this land requires improved drainage to achieve effective water table control. The remaining wetlands (15,640 acres) cannot practically be improved by drainage, water management, structural irrigation systems, or any combination of these practices because of topographic position, shallow soils over bedrock, or extremely tight and alkaline soils. These areas can be managed as salt and water tolerant pastures or as wildlife habitat or recreation areas. Those areas which are not suitable for drainage are probably more useful as wildlife habitat than those which are practical to drain.

Some of the area listed as improveable by drainage has been irrigated in the past and will require some irrigation for full production after drainage is installed.

POTENTIAL FOR IRRIGATION SYSTEM IMPROVEMENT

The physical potential exists to improve nearly all irrigation systems in the basin. This can often be accomplished best by a total system approach on a group project basis. Delivery systems can be upgraded by the installation of more efficient and flood resistant diversion structures; division, control, and metering structures; and canal consolidation, relocation rehabilitation, and lining.

Table VII-4 lists estimates of average present efficiencies of irrigation water use for various portions of irrigation systems. Ditch lining and land leveling can increase on-farm irrigation efficiency as much as 30 percent if properly designed. Properly managed and constructed furrows and corrugations can increase field application efficiencies to 70 percent. Level and graded borders and sprinklers can increase field efficiency to 80 percent with proper management. Conversion to sprinkler irrigation systems has the greatest potential in areas where soils and climatic conditions are conducive to producing the higher valued row crops. Where surface irrigation systems persist, there is potential for recycling

Table VII-3--Potential for wetland improvement through water level control

Location	Total area	Area which can be improved through drainage and agricultural water management	Area requiring improved drainage systems for land improvement	Area which cannot be improved
	acres			
Little Wind-Popo Agie River	4,500	3,820	1,580	680
Riverton irrigated area	37,000	31,450	12,950	5,550
Other Wind River areas	2,500	2,120	880	380
Bighorn River	6,000	5,400	2,100	600
Greybull River & Emblem Bench	31,600	25,280	9,480	6,320
Upper Shoshone River	4,200	3,650	1,340	550
Sage Creek and Lower Shoshone	11,500	10,000	3,680	1,500
Clarks Fork and Little Bighorn	500	440	160	60
Total	97,800	82,160	32,170	15,640

Table VII-4--Estimated existing irrigation system efficiencies

Estimated efficiencies and losses	Type of irrigation			
	I Large projects	I-II Smaller projects with company ditches	II-IV Individual systems with occasional irrigation	III-IV Individual mountain meadow waterspreading systems
	percent			
Delivery efficiency				
Canal efficiency (percent)	65	70	75	75
Farm efficiency (percent)	55	50	40	35
System efficiency $\left(\frac{\text{NIR}}{\text{Diversion}}\right)\%$ 1/	35	35	30	25
Canal losses 2/				
Canal loss (percent of diversion)	35	30	25	25
Canal waste and spill (percent of diversion)	10	10	10	15
Canal seepage (percent of diversion)	25	20	15	10
On-farm losses 2/				
Farm loss (percent of diversion)	30	35	45	50
Surface spill (percent of diversion)	10	15	20	30
Deep percolation (farm ditch & field) (percent of diversion)	20	20	25	20

1/ NIR is net irrigation requirement in a growing season.

2/ Loss is defined here as the portion of the irrigation water supply over which the man-made system loses control. It is not all lost from the surface or groundwater supply.

tailwater through tailwater collection and distribution systems. Most tailwater is of adequate quality for reuse as irrigation water and livestock water. Land smoothing and leveling offer potential doubling of field application efficiencies in some hayland areas which have never been smoothed or leveled.

POTENTIAL FOR RECREATION DEVELOPMENT

There is potential for the development of picnic and camping facilities on private lands, in communities, and in state parks. Well-designed, attractive facilities near well-traveled roads, in scenic areas, and with access to water should provide good returns on private investment and benefit the public by relieving pressure and demand for facilities in national parks, national forests, and public lands. This is likely to be the only way the needed camping facilities can be provided, since public funds for campsite construction are limited. This would release public funds to provide better access and other facilities on public lands. This action would minimize competition between the public and private sectors in providing recreation facilities. Private developers should remember that a poorly designed facility or a facility in the wrong location will not make a profitable return on an investment.

There is also potential for a national or state scenic park or monument in the southwest corner of Bighorn County, the northwest corner of Washakie County, and part of southeastern Park County. The area includes the headwaters of Fifteen Mile Creek, Elk Creek, and Dorsey Creek. This area of about 400 square miles is presently nearly all public land. It is an area of low rainfall, sparse vegetation, and highly colored bluffs, hills, mesas, and plains. It is close to two major access routes to Yellowstone National Park. Since it is at a relatively low elevation, camping is more comfortable early and late in the year than at higher elevation campgrounds and would be usable in all but the coldest winter months. This area could be developed as a staging area campground for visitors to national parks.

While there apparently is no great need for more surface area of lakes and streams for boating in general, there is potential for development of small, lowland lakes, close to towns and roads for use in water skiing. Large bodies of water and streams in the basin have limited usefulness for water skiing. Their waters are too cold much of the year, and long fetch distances for the wind encourage high wave action.

This basin is important locally, regionally, and nationally for its hunting and fishing. The potential exists for improving incomes from hunting and fishing on private lands by improving fish and wildlife habitat, providing facilities for hunters and fishermen, and charging for services provided. Many hunters and fishermen are apparently willing to pay and wait for reservations for improved facilities and services and a better than average hunting or fishing success at a convenient time.

POTENTIAL FOR FISH AND WILDLIFE HABITAT IMPROVEMENT

Fishery

Low streamflows in late season, siltation, undesirable fish populations, infertile water, lack of access, and some pollution, particularly oil field wastes, are factors which limit desirable fish production and fishing in the basin. Table VII-5 lists streams, lakes, and reservoirs where significant potential exists for improvement.

Big game

Big game herds can be increased if additional winter grazing is provided for them. This could be done through range restoration, selected forest thinning erosion control, reduction of livestock grazing, plantings, construction of watering facilities, and fertilization of winter ranges.

Waterfowl

Waterfowl habitat is quite limited in the basin. Reservoirs and lakes are important habitat, but small ponds, reservoirs, and marshlands are extremely important to waterfowl, and these are quite limited in the basin. Since small ponds are also needed for improved livestock grazing management, there is real potential for increasing the number of these small water areas.

Waterfowl habitat can be further improved through increased food supplies and plantings for cover and nesting sites. Table VII-6 lists important areas with potential for waterfowl and big game habitat improvement.

Upland game and other wildlife

Habitat for upland game and other wildlife can be improved in much the same ways as for waterfowl and big game. Food, undisturbed cover areas, and watering facilities can be provided on private and nonprivate lands to increase wildlife numbers.

POTENTIAL FOR LAND TREATMENT AND ADJUSTMENTS

Regardless of the ownership status, there is a potential for improved management practices and conservation measure application on the land not yet adequately treated and on land that will change its principal use. Potential for treatment and adjustments include:

a. Improving cover on cropland, forest, pasture, range, and wildlife lands.

b. Improvement of systems and water management on irrigated lands.

Table VII-5--Streams, lakes, and reservoirs with potential for fishery improvement (land and water required and benefits estimated) Yellowstone Subbasin [1]

Stream, lake, or reservoir	County	Present fishery class	Class change [2]	Acres or miles	Limiting factors	Potential for improvement	Resources needed: Land	Resources needed: Water [3]	Estimated potential annual fisherman-day increase: Use	Estimated potential annual fisherman-day increase: Capacity
Wind River, below Boysen Dam in canyon	Fremont	2	None	2	(1) Low flows	Provide minimum flow for fishery	0	400 cfs (Not consumed)		500
Bull Lk.Cr. - Bull Lake Dam to Wind River			3 to 2	3	Low flows	Provide minimum flow for fishery	0	90 cfs (Not consumed)		3,000
Shoshone R., Buffalo Dam to Heart Mountain Power Plant	Park	2	None	3	Low flows	Provide minimum flow for fishery	0	100 cfs (Not consumed)		1,500
Shoshone River Power Plant to Park Co.line	Park	3	3 to 2	30	(1) Low flows (2) Siltation (3) Pollution (4) Access	(1) Provide minimum flow for fishery (2) Control siltation from irrigated land and from Willwood Diversion Dam flushing (3) Control municipal and industrial pollution particularly oil field wastes (4) Provide access	0	200 cfs		13,500
North Fork-South Fork Shoshone River and tribs. above Buffalo Bill Dam	Park	1 & 3	3 to 2	125	(1) Irrigation diversion fish losses (2) Dewatering stream fisheries (3) Siltation (4) Access (5) Undesirable fish populations	(1) Install fish excluders (2) Supplement or restore more desirable flows below every diversion during irrigation season (3) Reduce siltation of streams by watershed control, particularly from irrigated lands (4) Provide access (5) Renovate and establish improved fish populations	100	[4] (Not consumed)	--	52,600

Table VII-5--Streams, lakes, and reservoirs with potential for fishery improvement (land and water required and benefits estimated) Yellowstone Subbasin 1/ (Continued)

Stream, lake, or reservoir	County	Present fishery class	Class change 2/	Acres or miles	Limiting factors	Potential for improvement	Resources needed: Land	Resources needed: Water 3/	Estimated potential annual fisherman-day increase: Use	Estimated potential annual fisherman-day increase: Capacity
Wind River, Bighorn R., Greybull R.	Fremont Hot Springs Washakie Big Horn Park	4 and 3	No change in class	Approx. 100	(1) Siltation and agricultural pollution (2) Rough fish	(1) Silt control by drainage-wide soil stabilization, with special emphasis on control of irrigation waste and return flows. (2) Install drop structures to control distribution of rough fish	0	0		5,000
Lakes and streams on Beartooth Plateau, Bighorn and Wind R. Mountains including Indian Reservations	Park Fremont	3, 4, and unclassified	4 to 3 and 3 to 2	--	(1) Access facilities, lack of information resulting in unused resources (2) Inaccessibility (3) Empty habitats (4) Stunted fish populations (5) Infertile water (6) Short ice-free season	(1) Roads, trails, campgrounds, signs (2) Maps, information, and education (3) Fish stocking (including rehabilitation) (4) Weed control (5) Fertilization (6) Lake deepening	0	0	--	--
Shell Canal	Big Horn	11	--	--	Diversion fish loss	Fish excluder facilities	0	0		--
Sunshine Canal	Park	--	--	--	" " "	" " "	0	0	(Excluders will prevent wasteful depletions and need for supplemental hatchery trout stocking.)	
N.Fk. Shoshone Ditch	Park	--	--	--	" " "	" " "				
Cody Canal	Park	--	--	--	" " "	" " "	0	0		
Lakeview Canal	Park	--	--	--	" " "	" " "	0	0		
Popo Agie Canals	Fremont	--	--	--	" " "	" " "	0	0		
Small Mountain Streams	Fremont	--	0 to 4	--	(1) "Cemented" gravel bottoms	(1) Stream improvement devices large numbers	0	0		--
Bighorn and Wind River	Big Horn	--			(2) Lack of pools and riffles	(2) Small retention dams to provide sustained or augmented flows (3) Bank erosion structures	0	0	Benefits would include (1) natural survival, (2) natural reproduction, (3) reduce silt loads, (4) reduce stocking required	

1/ Source: Missouri River Basin Interagency Study, July 1971. (Compiled from earlier data.)

2/ The class shown would replace "Present Fishery Class" if measures shown in "Improvement Opportunity" column were fully implemented.

3/ Estimated minimum flows in second-feet in this column are for cold-water fish. They are rough approximations representing about one-third of the average rate of flow of record from U.S. Geological Survey Water Supply papers. Exact flows at any one time would depend partly on other water needs (i.e., irrigation, power). Fish and game interests would be charged only with the difference between minimum flow to be maintained for the fishery and that which would otherwise exist.

4/ The magnitude of flows needed to be passed at each diversion cannot be estimated from available information, but minimum flows required would be equal to one-third of the average flow of record.

Table VII-6--Areas with potential for wildlife improvement, land and water required, and benefits estimated-Yellowstone Subbasin 1/

Resource area	Location or county	Acres involved (gross)	Limiting factors	Potentials for improvement	Resources needed			Estimated annual hunterman-day increase	
					Land acres	Water acres	Total acres	Use	Capacity
Wind River Basin Riverton Project	Fremont	10,000	(1) Waterfowl, migration, production, and wintering habitat in short supply (2) Limited hunting opportunity (3) Waterfowl depredations	(1) 1,500 acres of lake and marsh to be developed in several units under Wyoming Canal and in vicinity of Ocean Lake (2) 3,750 acres/10% irrigable on Cottonwood Bench upland	3,750	1,500 (4,000 a.f. consumed)	5,250 (acquire)		2,500
Oregon Basin	Park	2,000	(1) Waterfowl migration, production, and wintering habitat in short supply (2) Limited hunting opportunity (3) Waterfowl depredations	(1) 1,000 acres of marsh to be developed in 2 or 3 units along inlet canal to Oregon Basin Reservoir (2) Increase size of Oregon Basin Reservoir specifically for waterfowl use (3) Provide upland-game management habitat	3,000	2,000 (3,000 a.f. consumed)	5,000 (acquire)		700 (waterfowl, upland game)
Public lands	Basinwide	10,476,394	(1) Understocking (2) Overstocking (3) Land abuse (4) Watershed degraded (5) Poor wildlife habitat	(1) Range restoration (2) Forest thinning (3) Watershed erosion control (4) Big-game herds balance with carrying capacity (5) Reduction of livestock grazing (6) Pond construction and fencing (7) Fertilization	1,000,000	0	1,000,000		400,000
Watershed projects (PL 566)	Basinwide	12 projects	(1) Lack of public access (2) Small sediment pool and limited depth in reservoir (3) Lack of management (4) Interrupted stream flows (5) Channel alterations and loss of vegetation along watercourses. Increased bank erosion (6) Increasing silt loads in fishing waters through irrigation return flows	(1) Provide right of access to reservoirs; provide roads and trails. (2) Provide "recreation pools" over normal sediment pool storage. Insure minimum depths of 15 feet in over 20% of impoundment (3) Provide for state management. Dams to contain devices to drain sediment pools (4) Maintain stream flows below dams	--	--	--	--	--

Table VII-6--Areas with potential for wildlife improvement, land and water required, and benefits estimated-Yellowstone Subbasin 1/
(Continued)

Resource area	Location or county	Acres involved (gross)	Limiting factors	Potentials for improvement	Resources needed			Estimated annual hunterman-day increase	
					Land acres	Water acres	Total acres	Use	Capacity
			(7) Loss of habitat from drainage of wetlands created by excess irrigation waters (seepage areas)	(5) Minimize channel modifications; restrict clearing, grazing, and cultivation along streambanks. Replant denuded areas. (6) Reduce silt loads in irrigation return flows (7) Preserve "seepage" areas when these areas comprise valuable game habitat and improved new habitat in structural plans					
Private grazing lands, stock ponds	Basinwide	2,702,651	(1) Waterfowl migration and production habitat in short supply (2) Undeveloped nesting cover (3) Erosion and siltation (4) Livestock tramping	(1) Fencing of existing and new ponds (2) Eliminate grazing and erosion (3) Fish stocking (minor) (4) Seeding and habitat development					
Highway construction	Basinwide	--	(1) Right-of-way fences restrict game movements (2) Degradation of streams through channel alterations and loss of habitat through clearing operations and road routing	(1) Provide underpasses for game where fences are game proof. Adjust wire spacing to reduce entanglement by game jumping fences. (2) Reroute proposed roads; artifically create pools and cover in channeled reaches; restore meanders; modify drainage crossings to create waterfowl marsh or fish ponds, limit clearing.	--	--	--	--	--

1/ Source: Missouri River Basin Interagency Study, July 1971.

c. Protection of land against soil erosion and reduction of floodwater and sediment damages.

d. Changes in land use based on land capability classes.

FOREST LAND DEVELOPMENT POTENTIAL

Potential development for outdoor recreation

The major forest landowners and management agencies have accurate and recent estimates of the potential for recreation development. The Bureau of Land Management and the Forest Service are together responsible for more than half of the land in the basin. These two agencies have developed sites with a current capacity of about 1,660,000 visitor days per year. Another 998,000 visitor days of annual use can be satisfied on potential development sites inventoried.

There is additional potential as well as current development on private land, including the Wind River Indian Reservation, state parks, and other lands, and in Yellowstone National Park. With the additional capacity of undeveloped recreation areas in Yellowstone Park, the national forests, badlands, and other wildland in the public domain, it becomes obvious that the projected demand can easily be satisfied. Some changes in management philosophy will affect the distribution of use but not the capacity. For example, the Wind River Indian Reservation Tribal Council has chosen management activities aimed at reducing public recreation use while providing more opportunity for Indian use. The Forest Service is starting to emphasize recreation development at destination sites while deemphasizing the roadside campgrounds that serve as little more than bedrooms for passing tourists. The latter type of development is felt to be more appropriate for private campgrounds, and they are beginning to emerge as the market expands.

Potential development for timber

Although the theoretical potential for meeting the 2020 demand for timber is present, it is unlikely that the potential will ever be realized. The supply of timber could be roughly doubled by eliminating current losses due to diseases and insects. Realistically, only about half of this could be actually achieved.

It is estimated that intensified forest management, reforestation and regeneration, and new methods of harvesting on stands which are currently inoperable could provide a 50 percent increase in the wood supply.

Timber from land clearing, thinning, and other operations could be utilized more efficiently, and wood processors could improve utilization in their operations. This could provide about a 70 percent increase in harvest efficiency.

These management and utilization potentials are offset by significant

changes in management objectives. The national forest lands, which have produced about 75 percent of the timber in the past, are now managed to emphasize values such as aesthetics, wildlife, and recreation along with timber. Similarly, the forest lands of the Wind River Indian Reservation will be managed exclusively to preserve wildlife and recreation values with a near total exclusion of timber management activities. The effect of this kind of management will be to reduce the supply of available wood below the 1960 production level.

Potential development for forest land grazing

No specific need or unfulfilled demand for grazing has been identified. However, there is a trend toward expanded livestock production. In the future there may be increased pressure on forest range. Before an increase in grazing is allowed, the alternatives should be carefully evaluated. Intensive management and installation of fencing, water facilities, and range revegetation could increase the grazing potential.

Potential development for forest wildlife and fisheries

Most of the forest land is classed as summer range. This habitat can be manipulated and intensively developed to support more wildlife. The treatment would have little effect on wildlife populations, however, since it is lower elevation winter range which is critical.

Most of the fishing needs are satisfied by streams and natural lakes. Stream fisheries can be improved, restored, or enhanced, and additional reservoirs can be developed to provide variety. The physical potential for fisheries development appears sufficient to satisfy projected demands.

Potential development for water management and water quality

The needs for water management can be provided mainly through structural development and other project means. There is a potential for increasing water yield and prolonging water release through snowpack management in forest areas. The Forest Service is conducting research at several locations, and results are promising. However, there has not been enough application to justify extension of research findings from experimental areas to general forest areas. In addition, this basin has constraints on this type of work since most of the high elevation forests are classified as Wilderness or Primitive Areas, and vegetative manipulation is prohibited by Congressional Statute.

The primary water pollutant from forest land is sediment. There is a large potential for land treatment and regulation to reduce the causes of sediment production.

VIII. OPPORTUNITIES FOR DEVELOPMENT AND IMPACTS OF USDA PROGRAMS

The U.S. Department of Agriculture has participated in this Wind-Bighorn-Clarks Fork Type IV Study to gather an inventory of potential opportunities to solve water and related land resource problems through USDA programs. With such an inventory, a plan may be developed which can employ the limited USDA resources more efficiently and in such a manner as to solve the most pressing problems first. USDA programs and resources may thus be employed in a coordinated plan to solve the water and related land resource problems in an orderly manner. This chapter discusses identified opportunities for development through USDA programs.

OPPORTUNITIES FOR WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS

The Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended) authorizes USDA technical and financial assistance to local organizations for planning and construction of works of improvement in watersheds of 250,000 acres or less in size. The main purpose of any structure in a project must be either for flood prevention or agricultural water management. Secondary purposes may include recreation, fish and wildlife, municipal and industrial water, or pollution abatement. Project works of improvement usually include land treatment and structural measures. Individual storage structures may not have more than 12,500 acre-feet of floodwater detention capacity or more than 25,000 acre-feet of capacity for all purposes. The installation of structural measures is dependent on the completion of needed treatment on the watershed, and needed land treatment measures must be included in the watershed work plan as a condition for federal assistance.

The watershed map in figure VIII-1 shows the division of the basin into 97 watersheds. Reconnaissance surveys were made of each watershed, and those with significant problems which apparently could be solved through the small watershed project approach were investigated more intensively. Twenty-nine of the 97 watersheds were investigated intensively for project action. These investigations covered 5,000,000 acres, 38 percent of the basin, or 53 percent of the private land in the basin. Where project action was found feasible in the next 10 to 15 years, a watershed investigation report was prepared. Twelve watershed investigation reports were written for 17 of the 29 watersheds investigated. A short description of the potential project developments follows, and table VIII-1 summarizes some of the information available in the watershed investigation reports.

Lower Greybull River Watershed

The Lower Greybull River Watershed is located in Park and Big Horn Counties in the heart of the Wind-Bighorn-Clarks Fork River Basin. There are 202,933 acres in the watershed of which 45,230 are irrigated. The remaining area is primarily rangeland. Fifty-two percent of the land is

federally-owned and administered by the Bureau of Land Management. Forty-four percent is privately-owned and four percent state-owned. There are about 255 operating farm units in the watershed which comprise the Greybull Valley Irrigation District. This watershed includes areas irrigated from the Greybull River within the Dry Creek drainage.

Flood damages have occurred along the entire length of the Greybull River. The most serious damages have occurred in the lower reaches of the Lower Greybull Watershed. Nearly all of the irrigation structures on the river have been severely damaged, destroyed, or bypassed by serious floods. Some croplands have been flooded; others severely eroded beyond restoration. Farmsteads, farm roads and bridges, and nearly all county and state bridges have been destroyed. There is a probability of damaging floods in about 2 of 10 years. Average annual damages are estimated at $50,000. The most serious problems are damages to the irrigation structures in the changing river channel.

The agricultural industry in the watershed is based on the 45,230 acres of irrigated lands. The lands are used to produce forage for livestock, small grains, and row crops. Many of the lands in the watershed have become wet since irrigation has been introduced. Crop production has been abandoned. Wettest areas in the lands are used for low yielding pasture. In other areas crop production is limited and yields reduced. About 31,600 acres are affected by adverse drainage conditions.

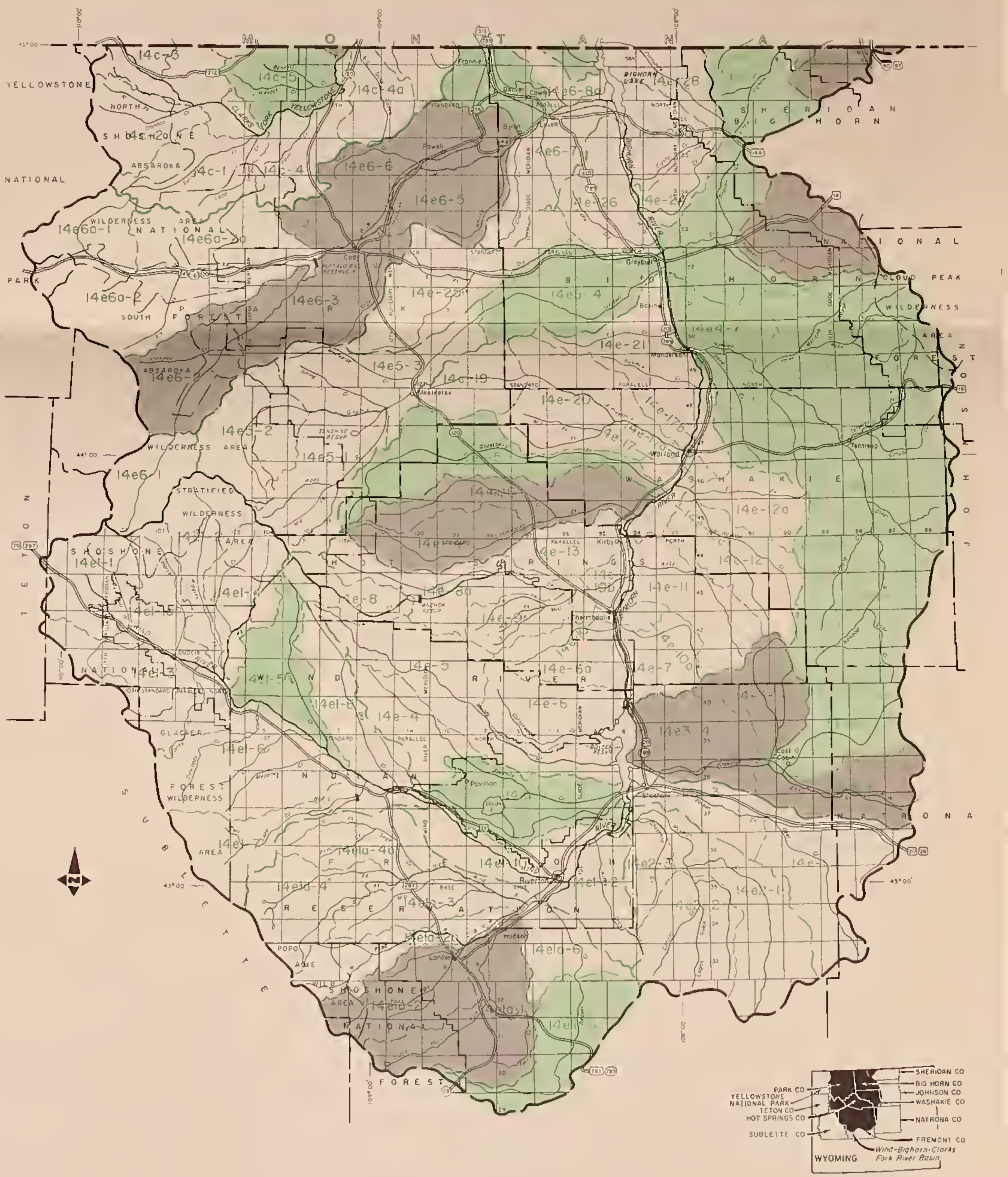
There is little potential for solving the flood problem by construction of floodwater retarding structures on the Greybull River or its tributaries. Reservoir sites which would provide flood control are practically nonexistent. Diking and channel improvement have been successfully completed in some places, but are extremely costly.

There is a potential for structural development of a drainage system including both open and closed drains. Two separate systems are proposed which would provide drainage for 21,200 acres of land that is now abandoned, undeveloped, or suffering from decreased production.

Nowood River Watersheds

The Nowood area includes seven watersheds as designated in the Wind-Bighorn-Clarks Fork Study. The area is located in the southeastern portion of the Bighorn Basin. It contains about 1,331,371 acres of which 27 percent is privately-owned; 7 percent state-owned; 50 percent administered by the Bureau of Land Management; and 16 percent within the Bighorn National Forest; and 1 percent are lands withdrawn by the Bureau of Reclamation. There are 20,530 acres of irrigated land; remaining private lands are primarily range and some timber lands.

The primary water-related problem on Nowood River is floodwater and related damages. Floods frequently damage crops, irrigation structures, farm bridges and roads, fences, and urban properties in the town of Manderson. Some flood damages occur almost every year. Average annual



WATERSHEDS INVESTIGATED FOR SMALL PROJECT ACTION

- Watershed investigation report completed
- Detailed field investigation, but no report published
- Field investigation only

FIGURE VIII-1

WATERSHEDS

WIND - BIGHORN - CLARKS FORK RIVER BASIN

WYOMING

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

DECEMBER 1974

SCALE 1:1,000,000

Table VIII-1--Summary of potential small watershed projects and their impacts, Wind-Bighorn-Clarks Fork River Basin, Wyoming

Watershed number and name		ECONOMIC IMPACTS: Annual benefits from WIR 1/	ANNUAL BENEFITS: Damage reduction	ANNUAL BENEFITS: Increased production	ANNUAL BENEFITS: External or secondary	COSTS: Total installation cost	COSTS: Annual cost 2/	Benefit to cost ratio (annual)	PHYSICAL AND BIOLOGICAL IMPACTS: Average annual surface water quantity change	Water supply timing improvement	Sediment load reduction	Vegetation improvement	Erosion reduction	Fish and wildlife: Location with improved habitat	Fish and wildlife: Location with reduced habitat	Increased recreational use	People served with new community water supply
		$/yr	$/yr	$/yr	$/yr	$	$/yr	ratio	AF/yr	AF/yr	AF/yr	acres	acres	acres of land or water or miles of stream		visitor days/yr	number
PRIORITY WATERSHEDS																	
14e5-4	Lower Greybull	821,000	0	724,000	97,000	3,900,000	264,580	3.1:1.0	+3,000	0	0	31,600	31,600	10,400 ac.	0 ac.	37,000	0
14e4-1-7	Nowood River Watersheds	200,370	126,970	44,490	28,910	1,627,500	111,220	1.8:1.0	-3,500	13,000	55	3,000	3,000	3,550 ac.	3,560 ac.	-	0
14e-15	Gooseberry Creek	71,000	0	59,000	12,000	832,000	51,400	1.4:1.0	-1,400	3,665	0.25	0	0	175 ac.	175 ac.	-	0
	Subtotal	1,092,370	126,970	827,490	137,910	6,359,500	427,200	2.6:1.0	-1,900	16,665	55.25	34,600	34,600	14,125 ac.	3,735 ac.	37,000	0
OTHER WATERSHEDS 3/																	
14e6-8	Sage Creek-Pryor Mountain	122,180	0	109,180	13,000	1,063,770	65,580	1.9:1.0	-600	1,480	1	0	0	170 ac.	170 ac.	-	0
14e-23	Lower Shell Creek	51,500	0	45,500	6,000	546,900	34,120	1.5:1.0	-1,300	3,370	1	0	0	203 ac.	213 ac.	-	0
14e1-5	Crow Creek near Tiperary	118,230	8,000	94,000	16,230	854,000	52,210	2.3:1.0	-1,600	9,900	1	2,600	2,600	2,845 ac.	2,845 ac.	-	0
14c-5	Cyclone Bar	134,240	0	109,700	24,540	840,000	58,030	2.3:1.0	-1,700	4,950	3	0	0	400 ac.	400 ac.	-	0
14e1a-5	Upper Beaver Creek	109,735	1,600	92,750	15,385	968,800	60,400	1.8:1.0	-1,400	12,900	16	766	766	1,196 ac.	1,196 ac.	-	0
14e-27	Crooked Creek	36,900	0	31,100	5,800	234,500	17,850	2.1:1.0	-3,100	7,000	0	0	0	0	0	-	0
14e3-2	Upper Badwater Creek	39,120	4,085	31,080	3,955	546,000	33,340	1.2:1.0	-400	1,620	1.5	0	0	70 ac.	70 ac.	-	0
14e1-9	Midvale	580,550	0	420,200	160,350	2,490,730	237,250	2.4:1.0	-35,000	0	0	16,830	16,830	16,830 ac.	16,830 ac.	-	0
14e1-9	Hidden Valley	57,400	0	57,160	240	253,500	15,970	3.6:1.0	-300	-	0.6	0	0	28 ac.	28 ac.	-	0
	Subtotal	1,249,855	13,685	990,670	245,500	7,798,200	574,750	2.2:1.0	-45,400	41,220	24.1	20,196	20,196	21,742 ac.	21,752 ac.	-	0
	TOTAL	2,342,225	140,655	1,818,160	383,410	14,157,700	1,001,950	2.3:1.0	-47,300	57,885	79.35	54,796	54,796	25,477 ac.	58,752 ac.	37,000	0

1/ Watershed Investigation Report

2/ Installation cost amortized at 5 5/8 annual percentage rate plus annual operation and maintenance costs.

3/ Some of these watersheds may become priority watersheds.

Watershed number and name		LAND USE AND AVAILABILITY CHANGES: Rangeland to cropland	Wetland to improved cropland	Cropland to wildlife and recreation land	Rangeland to recreation land	Land to water surface	Cropland with improved production	Rangeland with improved production	Potential for state agency involvement
		-----------	-----------	-----------	acres	-----------	-----------	-----------	
PRIORITY WATERSHEDS									
WYOMING									
14e5-4	Lower Greybull	0	10,400	0	0	N/A	31,600	-	Development of Badlands Scenic Area
14e4-1-7	Nowood River Watersheds	3,000	0	0	10	550	0	-	Irrigation and recreation cosponsor
14e-15	Gooseberry Creek	0	0	0	0	175	2,110	-	Transwatershed water development
	Subtotal	3,000	10,400	0	10	725	33,710	-	
OTHER WATERSHEDS									
WYOMING									
14e6-8	Sage Creek-Pryor Mountain	0	850	0	0	170	4,850	-	Recreation cosponsor
14e-23	Lower Shell Creek	0	0	0	10	203	1,940	-	Recreation cosponsor
14e1-5	Crow Creek near Tiperary	2,600	0	0	0	245	1,200	-	Irrigation and recreation cosponsor
14c-5	Cyclone Bar	0	0	0	0	400	5,060	-	
14e1a-5	Upper Beaver Creek	766	0	0	0	430	2,034	-	Recreation and wildlife cosponsor
14e-27	Crooked Creek	0	0	0	0	0	1,400	-	
14e3-2	Upper Badwater Creek	0	0	0	0	70	1,700	-	Recreation cosponsor
14e1-9	Midvale	15,580	0	0	0	0	0	-	Irrigation cosponsor
14e1-9	Hidden Valley	0	0	0	0	28	2,362	-	
	Subtotal	18,946	850	0	10	1,546	20,546	-	
	TOTAL	21,946	11,250	0	20	2,271	54,256	-	

direct floodwater and sediment damages on the Nowood River above Tensleep are estimated to be about $19,500. Between Tensleep Creek and Paintrock Creek damages are estimated to be about $26,500, and from Paintrock Creek to Manderson, $19,500. Damages in these reaches are primarily to agricultural properties. The U.S. Army Corps of Engineers has estimated average annual damages in the town of Manderson to be about $39,500. Other relatively slight damages have been experienced along the tributaries of the Nowood. Streambank erosion along the Nowood River damages and destroys arable land, diversion structures, canals, bridges, and other works of improvement. It is estimated that one-tenth of the irrigated land located along the river is subject to this type of damage. About 8.5 acres of cropland are lost annually by streambank erosion.

There is an opportunity to develop a structural program to retard floodwaters, store irrigation water, stabilize streambanks, provide recreational facilities, and enhance fish and wildlife habitat. There are about 290,000 acre-feet of water available for storage sites. Three potential structural projects appear to be feasible and could be developed as small watershed projects. Feasible structural measures consist of (1) a multiple purpose floodwater retarding irrigation storage reservoir on the Nowood River near Big Trails, (2) an extensive program of streambank stabilization along the agricultural lands in the Nowood River flood plain and some of the tributaries, and (3) a system of dikes and levees to protect the town of Manderson from the floodwaters of the Nowood and Big Horn Rivers. The multiple purpose structure could store 6,000 acre-feet of irrigation water and 7,000 acre-feet of floodwater. The irrigation water would be released into the Nowood River as needed and would be diverted for irrigation at various points downstream. The streambank stabilization program would be initiated from the multi-purpose reservoir downstream to Manderson. The areas to be treated would be restricted primarily to channel reaches where active streambank cutting is resulting in loss of valuable irrigated cropland or endangering developments such as roads, irrigation structures, and farmsteads. It is estimated that about 7 bank miles of the Nowood River channel and minor areas on the tributaries need treatment. The localized protection project at Manderson would be similar to that proposed by the U.S. Army Corps of Engineers. A system of levees completely encircling the town would protect it from the floodwaters of the Nowood and Bighorn Rivers.

The multiple purpose reservoir would reduce flood damages below the structure by about $28,550 annually, and would provide irrigation storage for about 3,000 acres of new lands. The combined average annual benefits would be about $91,280. The single purpose streambank stabilization program benefits would be about $22,000 per year. The single purpose flood prevention levee system around the town of Manderson would reduce average annual damages by about $87,090 per year.

Gooseberry Creek Watershed

The Gooseberry Creek Watershed is located in Hot Springs, Park, and Washakie Counties. It heads in the foothills of the Absaroka Mountain Range

in the southwest portion of the Bighorn Basin, and flows in an easterly direction to its junction with the Bighorn River at Neiber. It contains 232,284 acres, of which 3,820 are irrigated; 27,600 are forested, and the remaining are classified as range with some badlands in the lower parts.

Floods are infrequent in the watershed and cause only minor damages, as there is little development in the flood plain. The most serious water-related problem is the acute shortage of irrigation water. During an average year only 500 acres have a full season irrigation water supply. The soil and climatic conditions along the flood plain are capable of producing 4 to 5 tons of hay per acre. With the short water supply, hay yields are reduced to an average of 1½ tons per acre. About 24,800 acre-feet of water are needed to provide a full supply to presently irrigated lands. Under present conditions only 9,300 acre-feet are available in an average year.

There is no potential for solving the water shortage problem and providing a full-season supply for all existing irrigated land along Gooseberry Creek without importing water or providing large amounts of carryover storage.

There is an opportunity for development of a single purpose off-stream irrigation storage reservoir near the junction of Buffalo Creek and Gooseberry Creek. It would store 3,640 acre-feet of irrigation water and create a pool of about 175 acres. The reservoir would be filled by a diversion of high spring flows from Gooseberry Creek. The diversion structure would direct water into a 2 mile long 100 cfs capacity canal for delivery to the site. Irrigation water would be released from the reservoir as needed to supplement the flows of Gooseberry Creek during the latter part of the growing season.

The structural program would have very little or no effect on the floodwater and streambank erosion problems. The single purpose irrigation reservoir would provide an increased supply for 2,610 acres. All crop yields would be increased to near maximum during the years when a full season supply is available. It is expected that during short years available water would be used for selected areas and alfalfa establishment. Shortages would be reflected in average yields of hay and pasture. Net income per acre would increase by about $28. As many as 22 farmers could be affected by the project. Installation costs are estimated to be about $832,000. Average annual costs would be about $50,380. Average annual benefits would be about $71,000, and the benefit-cost ratio 1.4 to 1.

There also may be an opportunity to purchase up to 8,000 acre-feet of storage from the Lower Sunshine Reservoir and import it into Gooseberry Creek. This would assure a more complete supply to irrigated lands along Gooseberry Creek. Water would be diverted out of the Wood River into a 14 mile canal over the divide to Gooseberry Creek. Purchased water would be released into the Greybull River to equal the diversion rate. Flows in the Wood River appear to be adequate to sustain the Wood River irrigation requirements and to allow for diversion to Gooseberry Creek. The development

of transfer water by this means is outside the authority of the Small Watershed Program of the Department of Agriculture, but may qualify for assistance as a project measure of the Bighorn Basin RC&D Project.

Sage Creek-Pryor Mountain Watershed

This watershed is located in south central Montana and in north central Wyoming. It lies in Big Horn and Park Counties in Wyoming and Big Horn and Carbon Counties in Montana. There are about 393 square miles of drainage within the boundaries of the watershed with 235 square miles in Montana and 158 square miles in Wyoming. Ten percent of the watershed is irrigated farmland with the remaining 90 percent woodland, dry cropland, and native rangeland.

The major water-related problem in the watershed is the lack of adequate irrigation water during peak use periods of July and early August. The original Frannie Division irrigation project design was for approximately 14,600 acres. However, due to water shortages and irrigation inefficiencies, effective water supplies are not adequate to fully supply the 12,800 acres currently under irrigation. Inadequate drainage within the irrigated area has brought about salting problems. A third water-related problem is streambank erosion along Sage Creek and Polecat Creek within the irrigated land area.

A structural program could be developed to help solve the irrigation water shortage problem. Water could be diverted from the Frannie Irrigation Canal early in the irrigation season to an off-channel storage reservoir. A reservoir site 25 feet high with a capacity of 1,500 acre-feet has been identified about 5½ miles northeast of Deaver, Wyoming. Water then could be released from this reservoir during peak water use periods to supplement present irrigation water-short areas.

A land treatment program could be developed for the treatment of the salting problem. Irrigation water management would be the main feature of this program. Water management would include ditch lining to reduce seepage losses and increase delivery efficiencies; installation of water measuring devices to achieve improved water application; installation of tile drains to aid in reclaiming some of the wet, seepy areas; and reestablishing grass on some of the steep land that is presently being irrigated. Effective drainage through the installation of tile drains could be developed on 852 acres.

No feasible alternatives were identified to solve the streambank erosion problem. Proper irrigation water management would help reduce the erosion problem within the irrigated area.

Lower Shell Creek Watershed

The Lower Shell Creek Watershed is located in Big Horn County in the northeast part of the Bighorn Basin. The watershed has a total area of 204,547 acres and consists of Lower Shell Creek and its tributaries from

the town of Shell to its confluence with the Bighorn River near Greybull. About 10 percent of the watershed is forested, 5 percent is irrigated farmland, and the remaining 85 percent is rangeland and badlands.

The water-related problems in the watershed are floodwater damages, streambank erosion, and a shortage of irrigation water supply. The most serious water-related problem is the lack of early spring and fall irrigation water on lands for which no supplemental water is stored. The growing season begins in early May with moisture provided by snowmelt and rain. Irrigation water dependent upon snowmelt from the high mountain areas is not available until early June and is depleted by mid-July. Consequently, the crop yields are below that which could be produced. Hay, for example, yields about 2 ton less than what could be produced with a full water supply.

Lands which are affected in this manner are located along Horse Creek, Beaver Creek, and the lower extension of the Shell Canal. There are 380 acres of irrigated land on Horse Creek, all of which are short of water during the early spring and fall. There are eight operators on Beaver Creek who farm about 1,886 acres of irrigated land; about 660 of those acres are short of water in the early spring and in the fall. There are about 7,240 acres of land irrigated out of canals on lower Shell Creek. About 1,280 acres of late water-right land are serviced out of the Shell Canal extension. Water shortages occur to those lands in the early spring and late fall.

A structural program could be developed to help solve the irrigation water shortage problem. Water is plentiful during the late spring and early summer, but sufficient flows to meet requirements are lacking during much of the irrigation season. The average annual yield of Shell Creek is about 120,000 acre-feet, far in excess of the irrigation requirements. Good storage sites are scarce because of geologic and topographic conditions.

There is an opportunity to develop two single-purpose off-channel reservoirs for storage of irrigation water needs. An irrigation reservoir site with potential for storage of water for Beaver Creek irrigators is located in the Coyote Basin area between Beaver Creek and Red Canyon Creek. A diversion and canal from Beaver Creek would be utilized to fill the reservoir during periods of excess flow on Beaver Creek. Water for irrigation would be released into the draw for conveyance back to Beaver Creek as needed. A potential irrigation storage site for the Shell Canal area is located in the Poverty Flats area below the Shell Canal. The dam site is located in Scharen Draw. An embankment 40 feet high would store 2,000 acre-feet of irrigation water. The site has no appreciable yield from its drainage area and could be filled by releases from the Shell Canal during the irrigation off-season.

Crow Creek Watershed

The watershed lies to the north of the Wind River and is totally within the Wind River Indian Reservation. It contains 118,008 acres,

of which 2,606 are irrigated. There are about a dozen ranches in the entirely rural watershed.

The primary water and related land resource problems are floodwater damages and a shortage of irrigation water in the later summer and fall months. Floods cause an estimated $9,750 annual damage to irrigated cropland, irrigation structures, farmsteads, and other agricultural properties. Heavy sediment loads are deposited into the Wind River from Crow Creek and Sand Draw, causing damages to aquatic life and downstream water users. About 1,975 acres of land are irrigated from Crow Creek and are in short supply of water after mid-July. Average hay yields on those lands are only about 1 ton compared to 3 tons in similar areas with full water supply.

The opportunity exists to install a multi-purpose storage reservoir near Tipperary with about 10,000 acre-feet of storage. About 5,900 acre-feet could be used for irrigation to provide a full supply to 1,200 acres of presently irrigated and 2,600 acres of new lands. The remaining storage would retard flood flows and store sediment accumulation.

Cyclone Bar Watershed

This watershed is located in Park County in northwestern Wyoming with a small area in Carbon County, Montana. The watershed has a total area of 120,884 acres, of which 25,847 are private lands on approximately 21 operating units. Each unit has an average of 160 acres of irrigated land. About 72 percent of the watershed is used for grazing purposes, 25 percent is forested, and the remaining 3 percent is farm land. The water-related problems in the watershed include a shortage of irrigation water, flood damages to diversion and ditch structures on the tributaries, and severe winter icing on Littlerock and Bennett Creeks. The shortage of irrigation water during the early and latter part of the irrigation season is the primary problem. All of the irrigated land on the west side of the Clarks Fork River receives its supply from the small tributaries with the exception of a parcel at the mouth of Line Creek, which receives supplemental water pumped from the river. The drainage area of these tributaries is the high plateau area where snowmelt occurs in June and July and rapidly diminishes in the late summer. The irrigable land is quite gravelly with low water-holding capacity and should be irrigated with small applications at frequent intervals.

There is little potential for solving the water shortage and flood damage problems through reservoir storage on the small tributaries. Good reservoir sites are not available because of topography and the scarcity of suitable construction material. The water shortage problem could be solved by supplementing the flows of the tributary streams with water diverted from the Clarks Fork River.

There exists a potential to install a diversion canal from the Clarks Fork River in conjunction with a storage reservoir that will supplement the flows of Littlerock and Bennett Creeks. This system would provide a full supply 8 years out of 10 for 1,870 acres which are now irrigated

and 3,190 of nonirrigated grasslands below the canal. In addition, 206 acres of existing irrigated land above the canal would be assured a full supply because of reduced demand downstream.

Upper Beaver Creek Watershed

This watershed is located in southern Fremont County. The drainage heads in the Wind River Mountains near Atlantic City and empties into the Little Wind River south of Riverton. The watershed is about 12 miles wide and 40 miles long. Five operating ranches are headquartered near the creek. There are 180,744 acres in the watershed of which 22 percent are privately-owned and 68 percent administered by the Bureau of Land Management. About 1 percent of the land is used for cropland, 2 percent for forest, and the remaining is rangeland. The cropland is used to produce hay and pasture for ranching operations.

Floodwater and sediment damages in the watershed are relatively low. Some flooding occurred above U.S. Highway 287 causing damage to crops and other agricultural properties including canals, fences, and irrigation structures. The sediment produced in the watershed is deposited by the Wind River into Boysen Reservoir reducing its storage capacity and damaging wildlife habitat in the river. Average annual flood damages are estimated to be about $500 and sediment damages about $1,100.

The primary problem is a lack of irrigation water during the summer and fall. Beaver Creek is a snowmelt stream, having high flows in the early spring with very low flows during the summer and fall. There are about 940 acres in scattered tracts along the creek which are presently irrigated by direct flows. Because of the short water supply, yields are about one-third of their potential. Ranchers have indicated they intend to irrigate 297 additional acres along the creek. These lands will also receive only a short season supply. The lower two ranches have had to rely almost entirely on dryland hay for winter feed because of the lack of irrigation water. Yields on these lands range from .75 ton per acre during good years to no hay production in poor years, or an average of about one-half ton.

There is an opportunity to develop storage for supplemental water. There is sufficient water available to irrigate about 2,800 acres with a reliable supply. Upstream runoff is of good quality, but becomes polluted with sediment as it moves into the lower watershed.

A multi-purpose dam could be constructed which would store 9,400 acre-feet of irrigation water. Associated storage capacity of 1,600 acre-feet for sediment and 3,500 acre-feet for floodwater would insure the needed storage capacity and protect the structure from floodwaters. The water stored in the irrigation reservoir would be released into Beaver Creek as needed and would flow in the existing creek bed to where it could be diverted into an enlarged and extended Samuel P. Large Canal. The canal presently serves about 630 acres of land along Beaver Creek, and the extension could provide irrigation water for about an additional 2,650 acres.

Crooked Creek Watershed

The Crooked Creek Watershed is located in north central Wyoming and south central Montana. About one-fifth of the watershed lies in Big Horn County, Wyoming, and four-fifths in Carbon County, Montana. There are 84,546 acres in the watershed, of which 90 percent is native range, 9 percent forested, and 1 percent irrigated cropland. The forest land is located within the Custer National Forest and the Bighorn Canyon National Recreation Area. The irrigated area is located along the lower 8 miles of the Crooked Creek flood plain where six operating units carry on livestock-ranch enterprises. About 160 acres are irrigated on Gypsum Creek and a like number from Sykes Spring near Bighorn Reservoir.

The primary water-related problem in the watershed is the annual late season shortage of irrigation water. The watershed is located in one of the drier areas of the basin. After spring rains and snowmelt runoff from the Pryor Mountains, streamflows diminish rapidly to the small yields of springs in the area. An area of high water loss in Upper Crooked Creek further reduces the flows before they reach the irrigated lands. There is a definite need for a firm water supply for the presently irrigated lands and improved water management through rehabilitation of diversion structures and on-farm distribution systems. Approximately 250 acres of previously irrigated land have been abandoned because of the water shortage. There is a need to bring the land back into production to supplement and round out the existing operations.

Floodwater damages within the watershed are limited to the lower areas where overbank flooding occurs approximately every 2 years. Damages are limited to irrigation diversions, fences, roads, and bridges along Crooked Creek. Erosion damages are minor except for exposures of Triassic "Red Beds" in the central part of the watershed and shales in the lower reaches. Sediment from these sources enters Crooked Creek and damages ditches and cropland.

There is an opportunity to develop a firm water supply from an artesian well field by tapping the Madison limestone formation underlying the watershed. This formation underlies the lower watershed at depths of 1,200 to 1,350 feet. This formation is quite cavernous and is considered an excellent aquifer. The potential development calls for the installation of wells to provide a supplemental flow of 29 cfs. The 1,400 acres of irrigable land along Crooked Creek are estimated to require 34 cfs of streamflow during the peak consumptive use period in July. This demand is based on a project efficiency of 45 percent, and can be obtainable with a system rehabilitation and use of return flows in the lower reaches. Assuming streamflows of 5 cfs during this period the peak supplemental requirement is 29 cfs. It is estimated that up to 10 wells may be required. These wells would be installed along the Crooked Creek flood plain in the vicinity of the Montana-Wyoming state line. The flows of these wells will be regulated to discharge the irrigation supplemental requirement into the Crooked Creek stream channel for conveyance downstream to the individual diversion structures and supply about 1,150 acres of presently irrigated land and 250 acres of formerly irrigated land.

Upper Badwater Creek Watershed

The Upper Badwater Watershed is located in Fremont and Natrona Counties. The watershed is in the extreme northeastern part of the Wind River Subbasin at the headwaters of the Badwater Creek. Major drainages within the watershed are Sioux Creek in the upper portion of Badwater Creek, Dry Badwater Creek, and Clear Creek. There are about six ranches along Badwater Creek and its tributaries.

There are 133,843 acres in Upper Badwater Watershed, of which 42 percent are privately-owned; 11 percent state-owned; and 47 percent are federal lands administered by the Bureau of Land Management. There are about 1,730 acres of irrigated hay and pasture land. Approximately 10 percent of the watershed is forested, and the remaining acres are utilized as dry pasture and rangeland.

Floodwater damages in the watershed are primarily to agricultural properties along Badwater Creek below Sioux Creek. The damage is mostly to irrigated hayland and occurs almost annually due to heavy summer thunderstorms. Average annual flood damage in the watershed is estimated to be about $1,430. Average annual sediment and erosion damage is estimated to be about $6,250 from streambank erosion and sediment deposited in Boysen Reservoir.

The lack of a full season supply of irrigation water for the irrigated lands is a most critical problem in the watershed. Water rights are recorded for over 4,400 acres of irrigated land, but presently only 1,700 acres in four ranch units are being irrigated. Yields on these 1,700 acres are severely limited by the shortage of water.

There is a potential to install a small dam on Badwater Creek which would store 850 acre-feet of irrigation water. This would prolong the irrigation period for an average of one month on the 1,700 acres of irrigated land between the site and the town of Lysite. Associated storages of 150 acre-feet for sediment, and 770 acre-feet for floodwater would insure the needed capacity to protect the structure from floodwaters.

Midvale Watershed

The Midvale Watershed is located in Fremont County north of Riverton. There are 180,542 acres in the watershed, of which 59,710 are irrigated on 250 farm units. The watershed includes all of the Riverton Reclamation Project except the North Portal and Cottonwood Bench areas of the Third Division and the Hidden Valley area near Boysen Reservoir. The reclamation project has evolved through a series of stop-and-go decisions since it was started shortly after the turn of the century. All potentially irrigable lands in the watershed have not been developed by the reclamation project.

There is an opportunity to develop additional lands for irrigated crops in the watershed. Some of these lands (Airport Bench and the Big Ridge area) are above the existing canal. Another area (Muddy Ridge) was

originally included in the Third Division, but was never developed. Water could be delivered to the Big Ridge and Airport Bench areas by pumping through an underground delivery system from the Pilot Canal to irrigate about 4,880 acres on Airport Bench and 1,950 acres on Big Ridge. A third system could be developed for delivery of irrigation water to about 8,750 acres on Muddy Ridge.

The development of the additional 15,580 acres would provide an equivalent of an additional 60 acres to each of the existing units for farm expansion. Primary benefits would be about $27 per acre. Total annual benefits would be about $580,550. Installation cost would be about $2,490,730, annual costs $234,530, and the benefit-cost ratio 2.5 to 1. There is a legal complication for this watershed project regarding that part of the land to be irrigated which is presently withdrawn for a reclamation project.

Hidden Valley Watershed

This project is located in Fremont County, north of Riverton, and west of Shoshoni near the southern end of Boysen Reservoir. It is located within the boundaries of the Midvale Watershed described above but is listed here because it can be developed as a separate project. The total project area contains about 7,100 acres. About 2,360 acres are irrigated croplands served by the Pilot Extension Canal of the Riverton Reclamation Project. These lands are periodically short of needed water supplies because of fluctuations in deliveries, particularly as these are associated with rainy periods during the growing season.

Water management can be improved and water shortages reduced if a small reservoir is constructed as a part of the irrigation water delivery system. This reservoir should contain about 200 acre-feet and would cost about $253,500.

Economic impact of installing these projects

Installation of works of improvement can provide a stimulus toward economic growth and development. The complexity of relationships that exist between various sectors of the local economy and how they relate to the region and the nation make it an intricate task, if not impossible, to quantify all of the effects likely to occur. The basin's economy is made up of the aggregate economic activity of all its people. An initial change in one of its basic sectors will signal adjustments to take place in other sectors which will induce further changes and so on. The result of these changes can be quantified in terms of employment and income.

Employment will be generated as the works of improvement become operative. An employment multiplier can be used to estimate this impact. This approach involves a breakdown of total employment into two major occupational groups: (1) the basic group which includes agriculture, forestry, manufacturing and mining which produce goods and services locally for consumption mainly outside the basin; and (2) the derivative or service-oriented group which includes those whose goods and services are mainly

consumed locally. Total employment and incomes rise and fall with the basic group. A change in the basic activities sets a sort of chain recreation in motion that is reflected through all sectors of the economy.

A ratio of basic activity to derivative activity is computed from employment data as reported in U.S. Census of Population. This ratio is not static. The number of employees in the derivative group becomes larger relative to the basic group over long periods of time. Employment data from chapter III are combined to show the following:

Employment

Year	Total	Basic	Derivative	B/D Ratio
1940	15,953	8,765	7,188	1:0.82
1950	22,001	9,167	12,834	1:1.40
1960	24,790	9,111	15,679	1:1.72
1970	25,289	8,416	16,873	1:2.00
1980	29,100	8,300	20,800	1:2.50
2000	37,700	8,100	29,600	1:3.65
2020	47,900	7,800	40,100	1:5.14

The combined effects of changes in land use and crop yields on the benefited acres are major determinants used in evaluating the economic impact. About 85,000 acres in the watersheds investigated will be affected. Changes in land use are expected on onlv part of the total; however, nearly all of the benefited area will be used more intensively and efficiently. Hay, silage, feed grain, and sugarbeet production will be increased while range and native pasture production will decline.

By the year 2000, with the resource developments in place and operative, the gross value of agricultural production will be increased $4,076,000. Approximately 43 percent of the increase ($1,735,000) will come from lands that are irrigated at the present time but need either additional water or drainage. Supplemental irrigation water will be provided by the projects. The remaining 57 percent ($2,341,000) will come from land that is currently used for grazing but will be developed for irrigation as a part of the project.

Projected economic benefits will be realized across the basin and will contribute to economic development objectives. To the extent that

additional agricultural production and associated economic activity merely displaces production and activity in other areas or affects market prices, the benefits may not truly be national gains. Therefore, it is assumed that output increasing effects of the proposed developments are so small on an interregional basis, that any displacement or price effects would be insignificant.

The value of agricultural production per agricultural employee in 2000 is estimated at $29,700 [1/]. If it is assumed that agricultural labor resources are fully employed without the plan, the additional output will result in 137 additional basic employees. By applying the employment multiplier, it can be shown that derivative employment will increase by 500. The total impact on employment resulting from the increase in agricultural production associated with the programs is estimated to be an increase of 637 jobs. This is comparable to providing employment for all males between the ages of 30 to 49 in the study area that were reported as nonworkers in 1970. Conversely, if it is assumed that labor resources are underemployed to the extent that the increased production can come about without affecting employment, the basin-wide effect amounts to an average of an additional $260 net income per farm worker.

After deducting the nonfederal share of annual project costs from primary benefits, the remainder (approximately $1.5 million) can be considered as income to the basin. This increase in income is available for consumption spending. A portion of this increase will be spent in the basin and, in turn, respent within the area until its marginal effect becomes zero. A summation of these successive rounds of spending is commonly called the income multiplier. This approach measures the total change in income in the basin resulting from the initial change in income from a particular sector. Recent studies in areas with an economy similar to Wind-Bighorn-Clarks Fork Basin estimate the income multiplier to be from 2.00 to 2.18. If the entire $1.5 million were dispersed in the basin, the total income effect would be at least $3 million annually, which is an average of $31 for each resident. No attempt was made to project the income multiplier for the year 2000. However, as the basic-derivative employment ratio changes, the income multiplier will react in a similar fashion.

Local benefits can also accrue through the investment of nonlocal funds for resource developments. The federal share of installation costs and part of the project administration (construction inspection) costs for watersheds investigated in this study total $6,558,000. If a 15-year period is required for project installation and federal funds are provided in equal increments, this is equivalent to $437,200 annually. All of this investment can represent new income to the study area provided that a local contractor is employed and he purchases capital, labor, supplies,

1/ Gross value of agricultural production from table III-15 ($71,182,000) divided by the number of agricultural employees from table III-10 (2,400).

and machinery within the study area. The local economy could be enriched as much as $875,000 annually because the added increment of new income during the construction period is altered by the income multiplier.

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT OPPORTUNITIES

The basin area is included in a resource conservation and development (RC&D) project. A basic objective of the RC&D program is the orderly development, improvement, conservation, and utilization of natural resources of the area, thereby providing employment and other opportunities to the people of the area. The RC&D program is applicable where the acceleration of current land treatment and structural conservation activities, plus use of other authorities, will provide additional opportunities for the people.

A preliminary survey shows there are many diverse opportunities for RC&D project action through the potential of accelerated technical help and financial assistance. There are about 400 group irrigation systems needing improvements that could qualify for the project type action. Also, it is estimated there are about 170 group farm drainage projects which could qualify.

Problems with community, domestic, municipal, industrial water, and sewage disposal systems in some parts of the basin area may be reduced through project action. Other possibilities include various community recreation developments.

DEVELOPMENT OF A LAND TREATMENT PROGRAM

The concern for the proper use and management of land and related vegetative and water resources has been a primary reason for the existence of U.S. Department of Agriculture agencies since they were first created. The widespread practices of contour stripcropping, farm lot windbreaks, land terracing, gully plugs, selective forest cutting, and other such practices indicate a remarkable success in advancing the cause of proper land use in America. Nevertheless, much remains to be done before every acre of land is used according to its capabilities and treated according to its needs. Some of the practical opportunities for this basin are described in this section.

Land treatment for nonfederal lands

Proper and improved land treatment on private lands and leased state lands is the basic concern of the Soil Conservation Service in the U.S. Department of Agriculture. Proper land treatment is the basic element of small watershed projects. In order for a watershed project to qualify for a high priority, the needed land treatment measures must either be on the land or local people are ready, willing, and able to install most of them within a reasonable project installation period. Needed land treatment

measures, regardless of ownership, must be included in a watershed work plan as a condition for federal assistance. Acceleration of technical and financial assistance in developing land treatment measures can be provided to approved watershed project areas.

The conservation operations program of the Soil Conservation Service is an ongoing program of assisting land owners by providing technical assistance and advice in soil and water conservation in accordance with priorities and programs of local conservation districts. There is an opportunity to accelerate the application of land treatment practices through this program as conservation districts act to assign priorities and promote the development of these practices.

The Bighorn Basin Resource Conservation and Development Project (RC&D) is now in the operations stage. Funds available through this program will make possible accelerated technical services for soil surveys, conservation planning, and application assistance within approved specific project measure areas.

Currently 1,840,453 acres, or 36 percent, of the 5,115,210 acres of state and private lands in the basin are adequately treated. With the continuation of the existing rate of ongoing application, an additional 511,250 acres, or a total of 46 percent, of state and private lands will be adequately treated by the year 2000. The total installation cost to achieve this degree of treatment is estimated to be $35,173,000. The forage equivalent increase for this output is estimated to be 289,240 AUM's per year

If the rate of application is accelerated to almost double the existing ongoing rate, an additional 956,220 acres of state and private lands would be adequately treated by the year 2000. This would increase the total area treated to about 55 percent. The installation cost for this amount of treatment would be $52,400,000 with the forage equivalent increase for this output estimated to be 432,670 AUM's per year.

Table VIII-2 presents a detailed analysis of the economic effects for each of the major land use areas in the basin for both the ongoing program and the proposed accelerated program. A study of this table shows that the best rate of return per AUM for land treatment investment will be on rangeland. On state and private rangeland, treatments costing $2.63 per acre can increase the average annual forage yield from 0.26 to 0.38 AUM's per acre.

Although rangeland provides the best rate of return for land treatment investment, the major portion of the proposed annual forage equivalent increase will occur from land treatment measures which are installed on irrigated cropland. This production increase has been estimated to be over 2 AUM's per acre. In addition to the production effects, the proposed treatment measures for the irrigated cropland will improve irrigation efficiencies, control erosion, improve water quality, and reduce operation and maintenance costs.

Table VIII-2--Economic effects of projected land treatment alternatives on state and private lands

Land use and treatment practice	Area needing land treatment	Projected Existing Programs			Proposed Accelerated Programs		
		Applied by: year 2000	Installed cost	Annual forage equiv. incr. 1/	Applied by year 2000	Installed cost	Annual forage equiv. incr. 1/
	---acres---	--acres--	--dollars--	---AUM's---	---acres---	--dollars--	---AUM's---
Irrigated Cropland							
Irrigation and/or drainage systems	217,240	54,310		168,700	76,030		236,200
Water and cultural management	159,940	39,980		70,000	55,980		98,000
Cultural management only	53,830	18,840		4,700	26,920		6,700
Subtotal	431,010	113,130	34,000,000	243,400	158,930	50,000,000	340,900
Nonirrigated Cropland							
Erosion control	2,283	460		340	1,030		770
Soil maintenance and improvement	554	140		110	280		210
Subtotal	2,837	600	33,000	450	1,310	70,000	980
Range and Dry Pasture							
Planned grazing systems	2,156,810	323,520		32,350	647,040		64,700
Brush and weed control	555,600	55,560		11,110	111,120		22,220
Reseeding	7,400	740		370	1,480		740
Range renovation	13,890	690		350	1,390		700
Subtotal	2,733,700	380,510	1,000,000	44,180	761,030	2,000,000	88,360
Forested Land							
Forage improvement	80,970	12,140		1,210	24,290		2,430
Reduction of grazing	7,640	1,150		0	2,290		0
Subtotal	88,610	13,290	40,000	1,210	26,580	80,000	2,430
Other Lands							
Revegetation	18,600	3,720	100,000	NA	8,370	250,000	NA
TOTALS	3,274,757	511,250	35,173,000	289,240	956,220	52,400,000	432,670

Price base 1974. NA = Not Applicable

1/ All crop and forage production converted to AUM's of forage equivalents (i.e. 450 pounds of corn or 900 pound hog = 1 AUM).

Opportunities for national forest development and multiple use programs

Development

The discussion of potential forest development in Chapter VII indicates there is ample opportunity for accelerated development on national forest land. The implicit assumptions underlying the identification of potentials and of problems and needs are that the region will continue to supply forest-related goods and services at a rate equal to that of the immediate past. This is roughly analogous to the National Economic Development Objective described in the Water Resources Council Principles and Standards, and is the traditional Type IV River Basin approach.

The opportunities for development to help meet projections of demand for timber, recreation at developed sites, forage, and fish and wildlife are shown in table VIII-3. Accelerated early action is an opportunity on the four potential small watershed projects listed earlier in this chapter which include national forest lands. Forest Service development could be accelerated in conjunction with PL-566 projects on these areas if sufficient additional funds such as Water Resource Development and Related Activity Program (WRDRA) money is provided. National Forest development programs and projects could be accelerated to include almost all the remaining opportunity. Additional funds and manpower would be essential to convert these opportunities to reality.

In order to fully appraise the impact of Forest Service programs an alternative set of assumptions and opportunities has been identified. The alternative is roughly analogous to an Environmental Quality Objective and is very consistent with a broad management direction which emphasizes key values such as dispersed recreation, wildlife, natural beauty, and watershed protection. Development is not an important feature of this alternative, and much of the forest area is reserved formally as Wilderness or by management direction as nondeveloped area.

There is good opportunity to emphasize the key values of this "nondevelopment alternative." As previously mentioned, the Wyoming portion of the basin contains 1,345,800 acres of national forest land classified as either wilderness or primitive area. In addition, there is about 708,000 acres of roadless area (about 42 percent of the nonclassified national forest land) which provides substantial opportunity for dispersed recreation and retention of natural and wild characteristics.

Impacts

Complete implementation of development opportunities would have significant positive impacts on future timber supplies, future minerals production, future recreation opportunity, future livestock production, and future wildlife numbers. Concurrently, some negative impacts would occur, notably in future opportunity for primitive and unconfined recreation and wilderness type experiences. Development could have some adverse

Table VIII-3--Comparison of land treatment and structural measures planned and opportunities for an accelerated development alternative, Bighorn and Shoshone National Forests, Wyoming, 1970

Project Item	Unit	Estimate Unit Cost	Currently Planned	Development Alternative Opportunities	
				Potential PL-566 action	Other long range action
		---dollars-----			
Range revegetation & plant control	acres	10-20	14,600	2,200	19,800
Range distribution trails	miles	200-600	160	3	127
Range fences	miles	2000-2500	355	30	240
Forest planting or seeding	acres	220	5,400	100	900
Forest Management:					
Insect control	acres	25-250	700	500	4,300
Disease control	acres	5-70	0	3,400	30,600
Release, harvest, thinning, weeding	acres	30-70	23,100	1,900	17,300
Fishing stream improvement	miles	200-2000	40	40	780
Fishing lake improvement	acres	3000-10,000	200	360	4,190
Waterfowl habitat management	acres	400-600	0	5	20
Fence key wildlife areas	miles	2,500-3000	10	NA	25
Trail construction & improvement	miles	5000-8000	1,300	40	360
Road construction & improvement	miles	35,000	1,370	55	315
Roadside observation sites	each	5000	10	5	25
Erosion control:					
Gullies	miles	2500-5000	5	1.5	119.5
Sheet erosion	acres	100-1000	0	5	4,095
Abandoned roads & trails	miles	500-1000	0	0.5	260
Stream bank stabilization	miles	200-2000	0	2	28
Mining control & restoration	acres	100-500	0	5	20
Sediment basin construction	ac.ft.	5000	0	0	5
Recreation:					
New site development					
Camping - picnicking	sites	2,500	0	0	146
Boat launch	sites	15,000	0	0	8
Winter sports 1/	sites	200,000	0	0	7
Wildlife habitat management	acres	15-50	1,500	NA	10,200

1/ Does not include private investment.

impacts on landscape beauty, water quality, air quality, and the opportunity for special interest items such as scientific study.

Selection of the nondevelopment alternative would have significant negative effect on future production, especially of commodities such as timber and forage, and on opportunities for developed recreation such as camping, picnicking, summer homes, downhill skiing, and boating. Restrictions on access would eliminate motor vehicle use from many areas with a possible negative impact on grazing use, wildlife habitat development, wildlife harvest, mineral development, and the opportunity for structural water developments. The positive impacts would be primarily related to opportunities for primitive and unconfined recreation, solitude, special interest studies, water quality, air quality, and natural landscape beauty.

Table VIII-4 compares some impacts of development and nondevelopment alternatives. In addition, if the development alternative included installation of erosion control measures to the full extent indicated in table VIII-3, the following reductions in soil losses could be expected:

Measures	Annual soil loss reduction
	-----------tons-----------
Gully stabilization and control	38,700
Sheet erosion control	81,100
Stabilization of abandoned roads and trails	13,000
Streambank stabilization	9,300
Restoration and control of mining areas	7,500
Sediment basin construction	10,900
Forest planting and seeding	26,000

<u>State and private forest land development opportunities</u>

There are many opportunities for accelerated development on the state and privately owned forest lands in the basin. There are about 75,000 acres of nonfederal forest land within the project area of the identified potential small watershed projects which have some opportunity for accelerated forest land development. Existing cooperative forestry programs can be accelerated or initiated by employing a District Forester for this

Table VIII-4--Comparison of some impacts of acclerated development and non-development alternatives, national forest land, Wind-Bighorn-Clarks Fork River Basin, Wyoming.

Use, service, or product	Unit	Amount provided	
		Development alternative	Non-development alternative
Sawtimber and wood products	thousand board feet	107,000	27,000
Livestock capacity	thousand animal unit months	219.4	156.7
Developed recreation:			
camping	thousand visitor days	2,000	1,199.7
picnicking		289.8	133.0
boating		96.25	21.25
winter sports		481.2	292.5
Water yield	ave. annual acre feet	3,269,400	3,259,000
Wildlife harvest			
hunting use	thousand visitor days	240	200
fishing use		1,120.5	1,104.6
Dispersed recreation use	thousand visitor days	1,343.6	830
Opportunity for primitive and unconfined recreation, solitude and special interests	qualitative	reduced on about 700,000 acres.	No change
Natural landscape beauty	qualitative	reduced on some portions of area depending upon amount of new annual development.	No change

area as soon as funding is appropriate. Timber harvesting, timber stand cultural measures, insect and disease control, fire control, and reforestation are all measures which could be used to improve timber production from the basin's state and private forest lands. This increased timber can complement the timber output of the national forests and contribute to the projected demand for timber. Table VIII-5 shows the estimated opportunity for accelerated land treatment and management on state and private forest lands.

Table VIII-5--Existing land treatment program and development on state and private forest and rangelands 1/

Item	Amount: Existing	Amount: Proposed
	acres	acres
Forest inventory	20,047	320,253 2/
Timber management		
Accelerated harvesting	130 3/	108,100
Timber stand improvement	0	40,000
Insect and disease control	0	500
Tree planting and seeding	0	1,200
Area under fire prevention and control		
Forested lands only	291,005	340,300
Rangeland	2,890,086	4,170,050
Small watershed project assistance	0	75,000

1/ Rangelands are included here for fire control treatment only. See table VIII-2.

2/ This is primarily private forest land in the basin.

3/ This was on state land. Private harvest areas are unknown.

Source: Correspondence with Wyoming State Forester and Wind River Indian Reservation Forester, U.S. Forest Service Surveys and Wyoming Conservation Needs Inventory.

Development and management of other public lands

The Bureau of Land Management administers the unreserved public lands which have long produced wildlife and fish habitat, timber and other wood products, water recreation, minerals, and grazing for livestock. The bureau has an active program of range and watershed improvement including brush control, contour terraces and furrows, fencing, seeding, water-spreading, detention dams, diversions, stockwater ponds, and spring developments. It also has an active program of recreation site selection and withdrawal. The lands are classified for retention in public ownership or disposal to either private individuals or other government agencies. Some of these lands have been turned over to the National Park Service and the Bureau of Sport Fisheries and Wildlife for recreational and wildlife purposes, and other lands have been transferred to the Bureau of Reclamation for the purpose of irrigation or electric power development.

USDA cooperation and resource development on private and federal rangelands in the basin is in its beginning stages. This cooperation consists of assisting in the preparation of coordinated ranch and allotment plans and working through conservation districts for both private and federal lands. In ranch planning, all resources pertaining to the successful operation of a ranch are considered, particularly the crop and rangeland resources. When national forest lands are involved, a comprehensive plan involving these lands is considered. Recent plan developments and on-the-ground application of these plans have resulted in much improvement of the lands involved. Future operations will continue to conserve and develop the important public land resources.

RURAL RENEWAL AND DEVELOPMENT OPPORTUNTIES

Secretary's Memorandum No. 1667 provides for the establishment of A USDA Committee for Rural Development in each state. Membership includes representatives of the Forest Service, Soil Conservation Service, Farmers Home Administration, Rural Electrification Administration, the State Cooperative Extension Service, and the Economic Research Service.

The purpose of the committee is to establish liaison with the executive officers of the state government and other appropriate organizations. It is directed to work closely with state and local people in support of comprehensive planning and development. The committee is an important link in the chain of information and technical assistance flowing from the USDA to the people.

Secretary's Memorandum No. 1667 also calls for recognizing that development is the primary responsibility of the local people. Within the basin the organization of the conservation districts, the RC&D project, and other local development groups is a fertile field for carrying out the purposes of the rural development program. Each county in the basin has organized rural development county committees to work with the state committee.

OPPORTUNITIES FOR WILD, SCENIC, AND RECREATION RIVER AREAS

The Wind River has been identified and the Clarks Fork is being considered as having potential as wild, scenic, and recreation river areas that need further study to determine their suitability and availability for inclusion in the National Wild and Scenic River System. The existing features in these two areas are as follows:

The Clarks Fork River originates in southern Montana near Cooke City. It meanders into Wyoming near Pilot and Index Peaks. For the first 20 miles the river flows at a moderate rate through a wide flood plain dotted with ranches and native hay meadows.

At the confluence with Crandall Creek the river drops, literally, into a 20-mile long primitive, scenic, and practically unnegotiable canyon. At the canyon mouth the river flows northward through small ranching communities and finally joins the Yellowstone River near Billings, Montana. Upstream from the canyon mouth the river is mostly in federal ownership--Shoshone National Forest in Wyoming, and Gallatin National Forest in Montana. Downstream from the canyon mouth private ownership and public domain lands are intermingled.

The Clarks Fork River is free-flowing and it traverses an area with unique scenic, recreational, geological, historical, archaeological, fish, and wildlife values. The contrasting faces of the river from a placid, pastoral stream in the upper reaches to the awesome white water rapids, waterfalls, and deep pools in the canyon show little of man's influence. The population of the adjacent area is very small. The town of Cody, Wyoming, 38 miles away, is the largest population center. The Clarks Fork Road parallels about 11 miles of the canyon rim but never approaches closer than three-fourths mile. From the bridge near the Crandall Creek confluence to the Beartooth Highway the river is adjacent to the Clarks Fork Road. From the junction of the Beartooth Highway and the Clarks Fork Road to Cooke City, Montana, the river shares a broad valley bottom with U.S. Highway 212, the Beartooth Highway.

The Clarks Fork River supports a thrifty fish population and provides high quality stream fishing. Most of the tributaries to the river are very productive also. Sunlight, Crandall, and Dead Indian Creeks are rated as very good trout waters with the fisheries of state-wide importance. The Clarks Fork itself is rated as important trout water with the fisheries of regional importance. Black bear, grizzly bear, mule deer, elk, mountain goat, various predators, waterfowl, upland gamebirds, eagles, falcons, and other game and nongame animals are abundant in the canyon and upper river valley.

The area's historical significance stems chiefly from the journey of the Nez Perce Indians under Chief Joseph. The entire band including women and children, successfully eluded the U.S. Army by traveling down Dead Indian Creek, negotiating the face and sheer cliffs of the Clarks Fork Canyon. They emerged at the mouth of the canyon and escaped into central Montana.

There are several proposals for development which could affect the river. The Bureau of Land Management and Bureau of Reclamation have a power withdrawal along the length of the canyon portion. Two dam sites for hydroelectric power production have been proposed. One is in sec. 26, T. 56 N., R. 104 W., and the other is in sec. 10, T. 56 N., R. 105 W. Determination of which use, power production or wild and scenic river designation, has priority for this reach of the river will have to be made. A proposed all-weather highway is located in the canyon, but the location has been disapproved by state officials. The issue is quieted but not dead, as future pressure may be mounted to construct the highway in the canyon if the river is not included in the Wild and Scenic River System.

The Wind River above Boysen Reservoir has been identified for study for inclusion as a recreational river area. However, existing reclamation and irrigation projects significantly affect the flow of water in this section of the river. The Wind-Bighorn River from Boysen Dam to the mouth of Wind River Canyon flows through an area which has particularly unique geologic and scenic values which may also make this reach eligible as a recreational river.

No proposal for USDA action in these reports would significantly adversely affect the designation of any part of the Clarks Fork or Wind River as a part of the National Wild and Scenic River System.

In addition to the Clarks Fork and Wind River, some other streams in the basin that currently have not been identified but might also be studied for designation as a part of the National Wild and Scenic River System are as follows:

Wood River above its reservoir diversions
Greybull River above Pitchfork
North Fork Popo Agie above national forest boundary
Middle Popo Agie above national forest boundary
Medicine Lodge Creek above Hyattville
Paintrock Creek above Hyattville
Little Bighorn River above State Line
South Fork Shoshone River above Valley
North Fork Shoshone River above Buffalo Bill Reservoir
Tensleep Creek above Tensleep

Few of the streams listed above are well suited to recreational use for floating. The use of the Shoshone and Bighorn Rivers for this purpose might be enhanced more through a formal legislated declaration that the water surface, bed, and banks of these rivers below the normal annual high water line constitute navigable and public streams than by including them in the National Wild and Scenic River System.

Several locations for dam sites have been identified on the streams listed above. The value of these sites must be evaluated before these streams are designated as part of the national system.

The State of Wyoming Stream Preservation Committee has proposed legislation to study and classify the streams of the state. Their recommendations will be presented to the legislature for further action.

IX. INTERAGENCY COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

There are project and program opportunities and needs for resource development beyond the scope of existing USDA programs. Some of the opportunities can be developed without USDA action, but most can be enhanced if existing or enlarged USDA programs are included in interagency efforts. Changes in some of the existing programs and agency responsibilities or new programs may be required to best meet some of the needs of the people for the resources of the basin.

Chapter VIII discussed opportunities identified for existing USDA projects and programs. This chapter suggests some alternate approaches, describes some proposed developments and programs of other agencies, discusses the potential for using basin water resources outside the basin, and discusses the need for expanded USDA programs.

ALTERNATIVE APPROACHES

General

Alternative approaches to natural resource development in the basin range through a large number of combinations of USDA, other federal, state, local government, and private programs, projects, and regulation patterns. One possibility is that all organizations decrease and repress resource development. At the other extreme all organizations could choose to accelerate resource development. Neither of these alternatives is likely to occur. Another possibility is that no significant change in programs or rate of development will occur. This is also an unlikely prospect, since increased use of resources is expected both within and outside the river basin; and changes in priorities will affect federal and state programs. For example, the management policies of the National Park Service for areas outside the basin will directly affect opportunities for private and state recreational facilities in the basin.

In the near future, federal financial assistance in water and land resource development will probably decelerate. Technical assistance will probably still be available, and regulations may increase. Therefore, if the resources are to be developed to meet regional needs, state and private interests will probably accelerate. As priorities, needs, and situations change in the future, more federal financial assistance may become available, but any acceleration in federal assistance will most likely require a corresponding acceleration in state and private activity. Those states which become well organized in resource development will stand to benefit most when and if federal financial assistance is increased.

Specific alternatives in small watershed protection projects

Midvale Watershed

The primary opportunity in this watershed is the development of new

irrigated land. It is believed that most of this land is presently public land reserved by the Bureau of Reclamation and leased to private interests as marginal grazing land. Development through USBR programs will probably not occur in the near future nor is it likely to occur through USDA programs because of land ownership, project sponsor, program policy limitations. If early development of this project is desirable, the State of Wyoming and local private interests should investigate the possibility of acquiring the land and water and developing the project.

Cyclone Bar Watershed

Even though land use is not expected to change, this project is designed to irrigate land not presently irrigated. Some of the land is railroad land, and some is public land. Therefore, the same recommendation given above applies to this watershed.

Gooseberry Creek Watershed

The watershed investigation report for this watershed proposes a small reservoir for storage of supplemental irrigation water for presently irrigated lands. These lands would still need additional water. Some water may be available from Wood River through purchase and transport through a new canal. Since this canal could not be constructed in a single cohesive watershed unit, it is not likely that it would be developed under USDA programs. Early development of this project is essential if it is ever to be realized. Local private interests of the State of Wyoming should investigate the possibility of acquiring the water and building the system.

Crow Creek Watershed

This watershed is entirely within the Wind River Reservation and could be developed without USDA assistance. However, USDA assistance is available only if the Indian tribes will form a local sponsoring organization according to federal and state laws as so many other private organizations have done. Otherwise, this development will require other than USDA programs.

<u>Proposed projects of other federal agencies</u>

Bureau of Land Management - Bighorn Basin Project

The Bureau of Land Management has defined program needs in the basin as: (1) improved range management to bring 50 percent of the public range area to "good" range condition and the area now rated as "poor and bad" to "fair" condition for an annual increase of up to 208,000 animal unit months; (2) range and forest fire and insect protection; (3) resource development through contour furrowing, seeding, and sagebrush control to reduce erosion while improving the range; (4) forest management to improve timber yield and enlarge the timber industry; (5) development of new camping and other recreational facilities and upgrading of roads for access to public lands; (6) minerals inventory and development; (7) road construction;

(8) lands classification; and (9) cadastral surveying. An action program has been proposed to meet these needs. 1/

Bureau of Reclamation

a. Riverton Reclamation Project Extension

The original area proposed for the Riverton Project was 106,450 acres of irrigated land. Water is now delivered directly to about 57,000 acres. There are apparently about 14,450 acres of land, most of which is in the Muddy Ridge area of the project for which development has been deferred and which will require future congressional action to complete.

b. Polecat Bench Reclamation Project (Shoshone Extension (North))

This is a proposed extension of the Shoshone Reclamation Project to include 18,000 acres of new irrigated land on Polecat Bench and 1,200 acres in the Frannie Loop area of northeastern Park County in Wyoming. The principal features of the project would be the Polecat and Holden Canals, Holden Dam and Reservoir, two small pumping plants, and distribution and drainage systems. Water would be supplied from the Buffalo Bill Dam through the Heart Mountain Canal. Estimated diversions to the project are 70,000 acre-feet per year. If consumptive and evaporation uses for the project are about 50,000 acre-feet per year, then about 20,000 acre-feet per year would be released from the project in surface and ground-water flows.

Some of this return flow would probably go to Cottonwood Creek, a tributary of the Clarks Fork. The project is multi-purpose in that recreation facilities will be provided, and some fish and wildlife resources will be enhanced.

c. Transbasin diversion from the Wind-Bighorn-Clarks Fork River Basin to the Powder-Tongue Basin for industrial purposes

The Bureau of Reclamation has performed a reconnaissance survey and given options for up to 640,000 acre-feet of water in the Wind-Bighorn-Clarks Fork River Basin to be transported to points in eastern Montana and Wyoming for industrial purposes. One hundred ten thousand acre-feet are to be used on the Crow Indian Reservation. One hundred eighteen thousand acre-feet are to be used in other areas in Montana, and the remainder are to be used in eastern Wyoming.

The 640,000 acre-feet estimated above represent the estimated flow remaining after assumptions were made concerning development on the Wind River Indian Reservation, completion of the Riverton Project, depletions for smaller programs envisioned by other federal agencies, Bighorn Unit, Greybull Flats, Polecat Bench, Shoshone Extension (south), supplementation water to the Greybull Valley, the Hardin Bench Unit, new irrigated lands in the Crow Indian Reservation, completion of

---

1/ Wyoming's Bighorn Basin Project, USDI, BLM, Worland District, 1962.

developments at Hanover Bluff and Owl Creek, minimum streamflows for fishery requirements, and minimum flows for maintaining hydroplant capabilities.

There are several alternate project features being investigated. Pipelines up to 144 inches in diameter, up to 214 miles long, up to 30,500 feet of tunnels, several offstream storage sites, and several pumping plants are being considered. Some alternative project features use existing streams with increased flows for part of the transportation system. Costs of delivered water range from $85.00 to $135.00 per acre-foot. Most of the water will be used for coal hydrogenation. Once committed, there would probably not be much return flow. If there is significant return flow, a new pattern of agriculture might result in eastern Wyoming and Montana.

Nothing much has been done to estimate increased municipal water supply needs created by this industrialization, but it is assumed here that this problem will be included in other studies.

d. Modification of Buffalo Bill Dam

Buffalo Bill Dam is believed to be incapable of containing or passing safely the probable flood that might enter the reservoir without overtopping and damaging the structure. Demands on the storage of the reservoir are increasing both for supplemental water to existing irrigated lands and for supplies for new irrigated lands.

The safety of the dam can be assured by increasing the size of its spillway or by increasing the spillway size in less amount and raising the dam. The second alternative would increase usable storage by 181,000 acre-feet over the present storage of 421,320 acre-feet, and would require the relocation of roads and recreation facilities. Fishery, wildlife, and recreation needs have also been considered and might also be met by enlarging Buffalo Bill Dam. Water would be provided for the Oregon Basin Project described below.

This project could provide supplemental water to two early private irrigation projects--the Cody Canal, and through transfer, the Lakeview Irrigation District. A new hydroelectric power plant would replace the existing plant at the dam. There is also a potential for supplying municipal and industrial water for use within the Bighorn Basin.

e. Oregon Basin Project or Shoshone Extensions Unit (South)

This project depends on the enlargement of Buffalo Bill Dam and Reservoir described above. A full supply of water would be supplied to 17,270 acres of irrigable land. The principal project features would include the Oregon Basin Feeder Canal and an Oregon Basin Reservoir which would not require a dam. Two other canals have been

anticipated. The Dry Creek Canal is to be supplied from the reservoir, and the YU Canal was to be supplied from the Greybull River with water from the old Sunshine Reservoir. However, a new reservoir has been constructed recently on the Greybull system which may require changes in the plan for the Oregon Basin Project.

f. Clarks Fork Division in Wyoming

The Bureau of Reclamation's plan for development of land and water in the Clarks Fork Basin in Wyoming includes three dams and reservoirs on the main stem (Hunter Mountain, Thief Creek, and Bald Ridge) and a dam and reservoir on Sunlight Creek. These would provide water for three hydroelectric power plants and storage water for the full irrigation of 1,600 acres of irrigable land. This land is called the Badger Basin Unit and would obtain water from the river through pumping. The irrigation project is considered feasible, but the power production was not considered feasible at 3 percent interest rates by 1957 standards of justification. However, power production is considered essential to the development of coal, chromite, uranium, gypsum, and limestone deposits in the basin. Flood control and recreation benefits would also accrue. The irrigation of Chapman Bench was believed infeasible because of the estimated low productive capacity of the land. The Polecat bench area could be irrigated with Clarks Fork water, but is believed more economically irrigated from the Shoshone River as discussed above. The Fish and Wildlife Service believes moose habitat losses would be very important if this development proceeds. There would be other losses in habitat for deer, elk, bear, sheep, and sage grouse. The Corps of Engineers has made an estimate of flood storage requirements of up to 96,500 acre-feet. There may be some chance that the productivity of Chapman Bench and Clarks Fork Valley has been traditionally under-estimated. These estimates have been low because of the shallowness of soils over gravel. Modern sprinkler systems might provide the soil water moisture control needed for good production. However, high costs may still preclude development. Groundwater development in this area has probably not been seriously investigated.

g. Bighorn Unit

This is an irrigable area near Worland, west of the Bighorn River and west of the existing Big Horn Canal. Water would be pumped from an enlarged Big Horn Canal with three pumping plants to irrigate about 1,730 acres.

h. Greybull Flat Unit

This consists of 980 acres of irrigable land west of the Bighorn River near Greybull. Water would be pumped from the Bighorn River.

i. Cody Pump Area

This area of about 510 acres about 4½ miles north of Cody could be

served by pumping from the Heart Mountain Canal. Two pumping plants would be required.

J. Ralston Pump Area

One thousand five hundred acres about 8½ miles west of Ralston would be served by pumping from the Heart Mountain Canal.

k. Wind Division

This is a plan for the irrigation of 30,580 acres of new land, nearly all within the Wind River Indian Reservation. Storage regulation would be provided at the Wiggins Site, Raft Lake, and an enlargement of Bull Lake Reservoir. Supplemental water supplies would be provided to presently irrigated lands as well as drainage of some of these lands. Economic justification is considered marginal.

l. Other possibilities investigated by USBR

Emblem Bench, YU Bench, McCullough Section, Sage Section, Upper Dry Creek, North Dry Creek, Little Dry Creek, Whistle Creek, Table Mountain, Red Flat, Kane, Beaver Flat, Pease, Kirby, Hyattville, Bonanza, Manderson, Gooseberry, Schuster Flats, Buffalo Basin, Sheets Flat, Grass Creek, Wagonhound Bench, Putney Flat, Meeteetse Rim, and North Basin Pump.

Corps of Engineers

Manderson, Wyoming, is flooded from both Nowood Creek and the Bighorn River. A levee system has been proposed to provide protection to Manderson from ice jams and open water floods. A study concluded that the project is feasible and may be developed when local residents are able to pay for the local share of the costs.

Bureau of Indian Affairs

The BIA is assisting the Indian tribes of the Wind River Indian Reservation in the development of plans for new irrigation, improved agriculture, new industries, new recreational facilities, and several other projects expected to improve the standard of living of the residents.

NEED FOR FURTHER COORDINATION WITH OTHER AGENCIES

Bureau of Reclamation

USDA and Bureau of Reclamation programs are often quite compatible and should be coordinated. For example, the rehabilitation of existing irrigation systems and installation of drainage in reclamation project

areas can be accomplished through programs of both agencies. Education and technical assistance for improved irrigation water management is available from both programs. The Bighorn RC&D Committee could be a very important group to provide leadership in coordinating activities assisted by the two federal programs.

The Bureau of Reclamation and USDA agencies are interested in management of precipitation or weather modification as are state agencies. Individual agencies should not be allowed to pursue weather modification projects without interagency coordination.

Bureau of Indian Affairs

Activities on the reservation should be coordinated with other activities in the basin. Tribal councils should investigate the possibility of using more USDA programs and technical assistance to improve resource management practices on Indian lands.

Federal environmental agencies

Recently, a number of environmental agencies outside USDA have attained new prominence with legislative direction to regulate pollution, enhance fish and wildlife habitat, improve recreational facilities, and otherwise improve our natural environment. USDA agencies are working closely with these agencies to ensure that environmental values of water and related land resources are protected and enhanced. This cooperation is most effective when USDA agencies coordinate their efforts with other agencies early in the planning stage.

Other agencies should not overlook any opportunity to cooperate with USDA agencies. USDA agencies have large amounts of data about soils, water supplies, crops, and native vegetation and wildlife and have considerable expertise in natural resource management for protection of environmental quality.

Bureau of Land Management

Any program for the public land which affects grazing use will affect agriculture in the basin. A reduction in forage taken from the public land would require either a reduction in animal units in the basin or an increase in forage produced on private land. An increase in forage taken from the public land might reduce grazing pressure on private rangeland but would probably encourage an increase of animal units in the basin. This would also require increased forage production on private land, especially for winter feed.

Conversely, changes in the management and use of private forage-producing land can result in both positive and negative impacts on the public range. The timing as well as the amount of grazing is critical to the management of all rangeland. Therefore, any changes in grazing policies for the public land need to be keyed to programs to improve the management of all forage-producing land. USDA agencies can and should be actively involved in the development and coordination of such programs.

State of Wyoming

There are many projects which may be developed better with state assistance than with federal assistance alone because federal assistance is limited. The State of Wyoming should be encouraged to expand its present programs of technical and financial assistance programs in resource development. Technical assistance may be available from USDA agencies when financial assistance is not. A vigorous state program may enhance possibilities for federal assistance in the future. Cities, counties, and the State should consider the use of revenue sharing funds for land and water resource development or preservation. The State of Wyoming should seriously consider expanding the capabilities of state agencies to develop water resource projects. These should be multi-purpose projects which can include flood control as a purpose.

NEED FOR NEW OR ACCELERATED USDA PROGRAMS

History has shown that existing programs need to be modified or new programs proposed to meet changing regional and national objectives. The emphasis on conservation in the past has been largely focused on measures that would maintain the fertility and productive capability of the land. Although there is still need for these measures, conservation today and in the future must include practices that will protect, maintain, or enhance the environment. Public demands will necessitate new programs that will provide measures which will produce benefits to all people rather than just to the individual farming and ranching operation. These measures will improve water quality, improve and increase wildlife habitat, provide access for hunting and fishing, and develop additional recreation facilities.

It is estimated that only 46 percent of the nonfederal lands will be adequately treated by the year 2000 if present programs are continued at the present level of technical assistance and financing. If we expect to meet additional conservation needs and the changing environmental and recreational demands, both new and accelerated programs will be required; and increased local interest, financial incentives, and the technical assistance will need to be provided. A program such as or similar to the Great Plains Conservation Program, with its features of planning, scheduling, and contracting for installation of conservation measures, would greatly assist the application of these conservation programs in the basin.

Accelerated USDA programs are also needed for state and private forest lands. Cooperative fire management (CM-2) should be extended to the Wyoming counties not currently covered (Park, Big Horn, and Washakie Counties). Timber production, watershed protection, and land use planning needs could be met by accelerating the cooperative forest management, cooperative tree distribution, cooperative watershed, general forestry assistance, and tree planting and reforestation (Title IV) programs. Accelerated use of the advisory management program to assist the State Forester in managerial improvement, work measurement, work planning, and organization and management of programs, would have beneficial effects on all forestry programs.

Acceleration of existing watershed management programs on the national forests would reduce erosion and sedimentation and help stabilize water runoff. Production of needed goods and services from national forest lands could be enhanced by acceleration of on-going programs affecting resources such as recreation, wilderness, wildlife, livestock, and timber.

POTENTIAL USE OF BASIN'S WATER RESOURCES OUTSIDE THIS RIVER BASIN

The physical potential exists to transfer Wind, Bighorn, and Clarks Fork River waters to other river basins. The Powder River Basin, in particular, has forecasted needs far beyond its existing supplies. There is potential conflict between existing and future needs within the basin and those outside the basin. One proposal of the Bureau of Reclamation to build a project for this purpose was discussed earlier in this chapter.

The government of the State of Wyoming will surely be called upon to assign priorities and balance the use of water between river basins in the state.